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ABSTRACT

Developed for use primarily with students of grades five through nine, the activities presented in this book provide teachers and students with opportunities of exploring the science of aerodynamics. The activities are designed so that students can practice and apply the 22 skills and concepts related to flight in problem-solving situations. Each activity consists of student sheets and a teacher's guide. The teacher's guide contains information on the 12 activities including: (1) topic area; (2) introductory statement; (3) math and science skills; (4) required materials; (5) key questions; (6) background information; (7) management details; (8) instructional procedures; (9) student procedures; (10) discussion questions; (11) activity extensions; and (12) curriculum coordinates. (ML)

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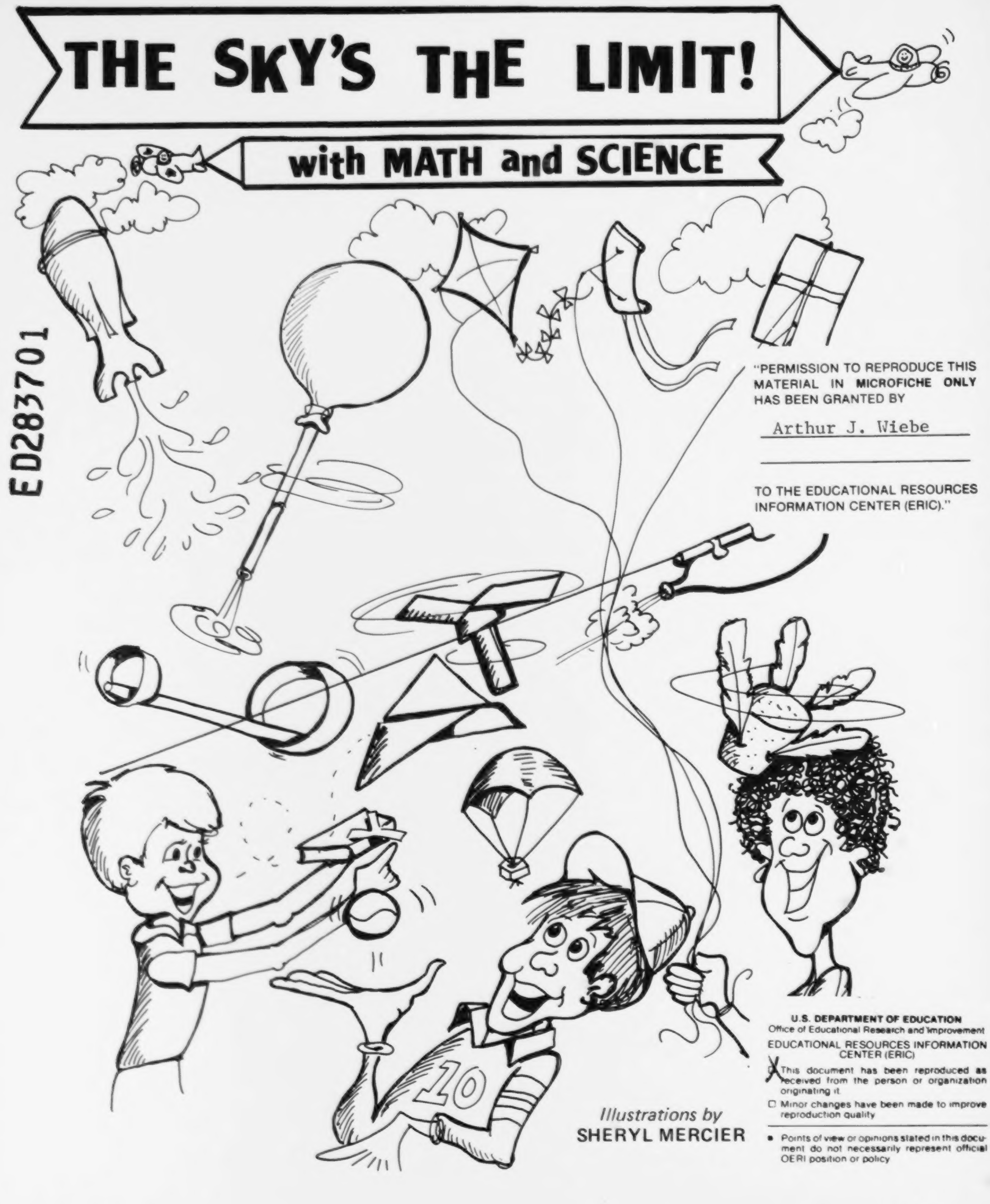

THE SKY'S THE LIMIT!

with MATH and SCIENCE

ED283701

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SE 047 234

Book 2

Aerodynamics

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Project AIMS

Project AIMS has as its purpose the integration of subject matter in K-9. Such integration enriches and makes learning meaningful and holistic. Project AIMS began as a program to integrate mathematics and science, but has since developed to also include language arts, social studies, and other disciplines. The acronym "AIMS" stands for "activities to integrate mathematics and science."

Project AIMS is a continuing, non-profit project of Fresno Pacific College. It had its inception in a National Science Foundation funded program to train teachers in the integration of mathematics and science. This quickly created the necessity to write instructional materials incorporating this concept. Despite the fact that thoughtful educators have long recommended this approach, very little appropriate material was available.

Currently, Project AIMS is funded solely through the sale of this developing series of books. All net proceeds from their sale flow into a trust fund administered by Fresno Pacific College. The use of this fund is restricted to the support of continued research and development, partial scholarships for classroom teachers who participate in the writing and field testing teams, and the publication of the books.

Two writing teams have completed their work. The first consisted of seventy-five teachers in grades 5-9 who met over a period of eighteen months. The second involved thirty-five K-4 teachers who wrote during a two-year span. In the fall of 1985 a third team of approximately fifty teachers in grades 2-9 will begin writing. In addition, over a hundred teachers have been involved in field testing newly created materials.

The rationale for this integrative thrust lies in the fact that science, mathematics, language arts, social studies, etc., are integrally interwoven in the real world outside the classroom, from which it follows that they should be similarly treated in the classroom if we are to prepare our students for life in that world. Teachers who have used Project AIMS lessons give enthusiastic endorsement to the effectiveness of this approach.

Science encompasses the art of questioning, investigating, hypothesizing, and discovering. Mathematics is the language that provides clarity, objectivity, and understanding. The language arts provide us with powerful tools of communication. Many of the major contemporary issues involve societal issues stemming from advancements in science. It is time, therefore, that all of us in the teaching profession take seriously using a more holistic mode of transmitting knowledge to students. It is this that motivates all of us who are involved in creating or using the integrative materials of Project AIMS. We invite you to join us in this effort.

Extensive field testing of these materials confirms the following beneficial results.

1. Mathematics becomes more meaningful, hence more useful, when it is applied to situations that interest students.

2. The extent to which science is studied and understood is increased, with a significant economy of time resulting from the integration of two or more disciplines.

3. There is improved quality of learning and retention, supporting the thesis that learning which is meaningful and relevant is more effective.

4. Motivation and involvement are increased dramatically as students investigate real world situations and participate actively in the process.

We invite you to become part of this classroom teacher movement by using an integrated approach and by sharing any suggestions you may have or investigations you would recommend. Project AIMS welcomes you!

Project AIMS Publications

GRADES 5-9 SERIES

- Math + Science, A Solution
- The Sky's the Limit
- From Head to Toe
- Fun With Foods
- Floaters and Sinkers
- Down to Earth
- Our Wonderful World
- Pieces and Patterns, A Patchwork in Math and Science
- Out of This World, Book A

GRADES K-4 SERIES

- Fall Into Math and Science
- Glide Into Winter With Math and Science
- Spring Into Math and Science
- Seasoning Math and Science, Book A (Fall and Winter)
- Seasoning Math and Science, Book B (Spring and Summer)
- Jawbreakers and Heartthumpers
- Hardhatting in a Geo-World
- Popping With Power
- Overhead and Underfoot

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Fresno, California 93727

I HEAR, AND I FORGET

I SEE, AND I REMEMBER

I DO, AND I UNDERSTAND

—Chinese Proverb

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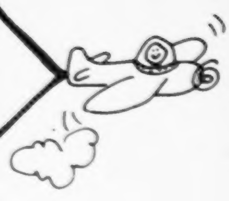
THE SKY'S THE LIMIT!



with MATH and SCIENCE

INTRODUCTION

As the title of this book implies, the sky *is* the limit, if there is one, to the knowledge and experience that can be gained by doing these investigations. As simple and inexpensive as they are, these activities explore virtually every aspect of the science of aerodynamics.

Most investigations contained in *The Sky's the Limit* were designed primarily for grades four through eight, but they can easily be adapted for use with a wider range of students. Whether they are ready for an intuitive grasp of a general concept or the mastery of sophisticated scientific theories, students will be challenged to observe, predict, test, and generalize. Beginning with a specific question, each investigation tempts the students to open their minds, draw upon a variety of experiences, and explore a new range of possibilities, while simultaneously motivating them to support their ideas with precise data and accurate calculations.

The real beauty of these activities is that almost all provide practice and application of the basic skills in a problem-solving situation— a major thrust of education today. You probably will hear, "Gee, we didn't even have to do any math today," after your students have just completed an entire page of computing averages. Furthermore, with each activity, they will become more comfortable with the tools of science and mathematics, both the equipment and records which help us to "chart" and understand our world, which will help them to "map" and build their world.

One word of caution, however, before you take off: many students may approach you begging for extra materials from the day's investigation, so that they can set up at home and do it again! Students are indeed interested and do become involved.

Above all, *The Sky's the Limit* tries to speak to the dreamer and the explorer, the child who dares to wonder, which is in all of us. Daedalus, daVinci, Verne, and Goddard; the hang glider, the helicopter, the Concorde, and the Columbia—man's fascination with flight is eternal even though his knowledge is always increasing. Each frontier crossed offers a new frontier beyond! So it should be with this book: each question answered should generate new questions; each problem solved should create a new problem to explore. Flying is "magic" for children of all ages! This book attempts to clarify some of the reasons why the magic works while preserving its sense of mystery. As Albert Einstein expressed it: "The most beautiful thing we can experience is the mysterious. It is the source of all true art and science."[1] Flight is beauty, art and poetry; it is science, math, and engineering. It is man's aspirations and inspirations, his past and his future, his dreams and his hope—a mystery worthy of a child's curiosity.

"No bird can soar too high if he soars with his own wings."

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[1] "What I Believe," *Forum*, October, 1930.

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Charter subscribers may renew their subscription to the AIMS Newsletter for 1987-88 at a special $20.00 rate even though the annual subscription rate has been increased to $22.50. **Subscription renewals must be received by June 15, 1987 to be eligible for this special rate.**

Current readers are aware of the fact that the content of instructional materials which can be duplicated for classroom use has increased during the first year of publication. This increase in the subscription rate reflects the added cost of this expansion.

Initially, the Newsletter featured three new AIMS investigations. Some of the issues in the current year already contain four new AIMS activities. All issues in the 1987-88 subscription year will have four AIMS investigations selected from the new materials now being field-tested by the writing teams. These will reflect the ten new topic areas currently under development.

The science poster will continue to be included in each issue.

A new feature introduced in the February, 1987 issue which will become standard in 1987-88 is a second set of mathematics posters in a new series. This series will provide another set of excellent problem solving activities involving higher order thinking skills. A thorough analysis of problem-solving approaches appropriate to each problem situation in this series will be included. This analysis will serve as an aid to classroom teachers who wish to enhance their own knowledge of problem solving and in helping students acquire an inventory of problem-solving skills. Authored by Dr. Arthur Wiebe, it joins the series authored by Wilbert Reimer. Both Wiebe and Reimer studied extensively under Dr. George Polya at Stanford University and his influence is reflected in these problems.

The ten issues will contain forty new AIMS investigations, ten science posters and twenty problem-solving challenges, plus numerous articles dealing with the teaching of "hands-on" science, evaluating higher order thinking skills and student progress in mastering process skills, and developments in the AIMS program.

Beginning in May, 1987, the entire set of ten 1986-87 issues will be available as a packet for $22.50. This set will have a total of 35 AIMS investigations, 14 mathematics posters, 10 science posters, and numerous articles of permanent value, including a thorough discussion of the Model of Mathematics and its application in improving mathematics instruction.

New subscribers who order both the 1986-87 packet and enter a subscription for 1987-88 are offered the special combination price of $40.00, which represents a saving of $5.00 over separate purchases.

Since duplication rights for one school site are granted for all materials published in the Newsletter, it is highly cost effective for a school to enter a subscription for the use of all of its teachers.

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...on a Spool

Materials: wooden spool (thread)
2"x2" piece of tagboard
straight pin

Procedure:

1. Make sure to remove the paper labels from each end of the spool so that you can blow air through the center hole.
2. Stick the pin through the center of the ...
3. Place the pin and paper on top of the ... in center hole of spool to ...
Tilt your head back and ... vigorously for about ...
Make sure ...
Tilt your he...

2. Pull off a thi...

3. Place the onion slice on the center. Add a drop of water and the ... Place on the microsco...

...serve the onion slice under low ... Draw a few cells and label ... cell wall

...Clown

Materials: Clown
pencil
2 coins
Masking tape

Procedure:

1. Trace and ... of the ...
2. ...

COMMON CENTS

Do all pennies have approximately the same mass?

For this investigation, select one set of pennies minted before 1982 and another set of pennies minted after 1982. Find the average mass of each type.

Average Mass ... Penny

TRIANGULAR NUMBERS

Triangular numbers are numbers which can be represented by dots in an equilateral triangular array. The first four triangular numbers are pictured below.

1st 2nd 3rd 4th

...ULAR | NUMBER OF DOTS

Rubber Eggs

1. First, soak raw eggs in vinegar for about ... will take the calcium out of the shell. ... To "see through" the egg's membrane ... notice about the eggs in vinegar?

... out 1 decalcified egg. Blot it dry. Roll it ... paper towel, and your arm. What do you ...

...nd 2 decalcified eggs of about the same si... paper towel. Estimate, then weigh and m... for each.

	Egg #1 Estimate	Egg #1 Actual	Egg #2 Estimate	Egg #2 Actual
Mass	g	g	g	
Circumference	cm	cm	cm	

4. Place egg #1 into a jar of water and eg... ...rn syrup. Describe your observations: ...

...think will happen: ...

TEDDY BEARS Playing in the Den

...ddy Bears are playing a game in their den. They are hidden from view. ... while, 6 are sent out while the rest lay their plans in ... the 6 who come out are selected at random. Some have been ... out before, some are sent out for the first time.

Your task is to make the best guess as to how many Teddy Bears there are of each color.

...ess

... think there will be more ______ Teddy Bears than any other co...
... think there will be fewer ______ Teddy Bears than any oth...

...ick out 6 Teddy Bears for each sample without looking into the de... the number of Teddy Bears of each color in the sample has been ... them back into the den, mix them up thoroughly, and pick 6 ... ...ples have been checked.

	Blue	Red	Green	Y...
First Sample				
Second Sample				
Third Sample				
Fourth Sample				
Total				

AIMS NEWSLETTER

A Publication of the AIMS Education Foundation

Volume 1, Number 6 — January, 1987 — AIMS Education Foundation

AIMS On Target In China

Chinese Students Measure Up

Rose Lee Patron

AIMS NEWSLETTER

A Publication of the AIMS Education Foundation
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Volume 1, Number 7 — February, 1987 — AIMS Education Foundation

AIMS Education Foundation Outlines Five-Year Plan

Auburn, AIMS, Action!

Activity-Centered Science Partnership

Dr. Del Alberts, Auburn District Superintendent

A Perfect Pineapple

Circumference — Estimate, Measure, Find Difference

I think the greatest circumference ... I measured and the greatest c... There was a difference between my estim...

Height

Mass

... the height of the pine... actual height ...

The TEDDY BEARS Go Sledding

Basic Operations and the Model of Mathematics

Dr. Arthur Wiebe

Connectors and Addition

AIMS NEWSLETTER

A Publication of the AIMS Education Foundation

...1, Number 5 — December 1986 — AIMS Education Foundation

...waii Selects AIMS for Statewide Program

Miles Muraoka
State Educational Specialist in Science

2. A third a blue in to ...

Diagonal Challenge

Find the total number of diagonals in a polygon with 12 sides by first examining a polygon with 3 sides, then a polygon with 4 sides, etc. until you see the pattern that emerges. Use the chart to record your results.

Number of Sides	Number of Diagonals
	0

The Fascinating Triangle

EGG FACTS

Minerals: iron, phosphorus, vitamins A+D, ... plus a small amount of ...

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SEEING IS BELIEVING!

I. **Topic Area**

Introduction to flight principles

II. **Introductory Statement**

Using a series of discrepant events, we will explore a variety of aerodynamic concepts.

III.

Math Skills	**Science Processes**
a. Observation	a. Observing
b. Timing an event accurately with a stop watch	b. Predicting
c. Recording data	

IV. **Materials**

Newspaper
Old yardstick or wood lath (available at a lumber yard)
8½" x 11" paper
Various sized balls
Thread spool
Straight pins
Candle
3" x 5" index cards
Student page 1

V. **Key Question**

"What will happen if . . . ? (See X. **Discussion** for specific questions for each activity.)

VI. **Background Information**

The activities in this lesson (illustrated in the Student Book, page 1) should leave the students wondering. The outcome of each part of the experience may seem to go against common sense. These "discrepant" events are keys which will open discussions and lead to further investigation.

#1 Newspaper Lift

Air, like all matter, has mass and exerts pressure on objects. At sea level, this pressure is roughly 15 pounds per square inch (15 psi). In this activity, students will see a dramatic demonstration of this fact. If one calculates the weight of air on a single sheet of newspaper, you can see how significant this weight can be. (length 28" x width 24" x 15 psi = 10,080 lbs)

#2 Paper Blow

As the student blows across the top of a piece of paper, it will be lifted up. This may seem strange to the students until they understand that as air moves faster, the pressure is reduced, thereby creating a vacuum that "lifts" the paper.

#3 Ball Drop

We have Galileo to thank for this activity. In this classic investigation, we see that gravity acts on all objects with the same force, no matter what the mass or size of the objects. The balls will strike the ground at the same time. Stress the importance of dropping the balls at precisely the same instant.

#4 Spool and Card Blow

"Logically," if you blow air through a tube, it should push an object away from you. (Consider the lowly peashooter.) In this activity, students find that this " . . . ain't necessarily so." As the air spreads out between the card and spool, it moves faster than the surrounding air, thus lowering the pressure and, again, creating a vacuum. The students will find that the harder they blow, the greater the vacuum created.

#5 Candle and Card Blow

This is one more example of moving air producing a low pressure area. As the student blows on the card, the air rushes outward from the center of the card. This increases the speed of the air at the edges of the card, creating a vacuum that pulls air from behind the candle flame. As air moves to fill the space left, the flame is bent toward the card.

VII. **Management Suggestions**

As a starting activity, this is a teacher demonstration using student helpers. This will take one class period or approximately one hour.

VIII. **Procedure**

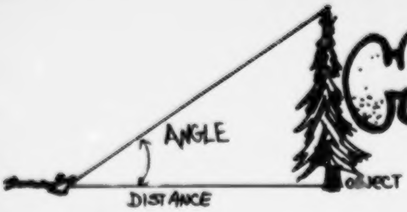
1. Collect all materials listed in the materials section.
2. Ask the students to predict the outcome of each of the activities.
3. Have student helpers do each activity in front of the class as many times as needed for the students to feel satisfied with their observations.

IX. **What the Students Will Do**

1. Predict and observe the outcome of each event.
2. Student helpers will participate actively, doing each of the activities.
3. Students will discuss their findings.

X. **Discussion**

1. How could one sheet of newspaper be stronger than a piece of wood?
2. What made the paper rise when we blew over it?
3. Why doesn't the heavier ball hit the ground first?
4. What held the card to the spool when we blew through the spool? And, why does the card get closer to the spool the harder we blow?
5. What caused the candle flame to move toward the card?



HOW HIGH IS IT?

I. **Topic Area**

Clinometer

II. **Introductory Statement**

We will use a clinometer to find the heights of various objects.

III. **Math Skills**
- a. Measurement-linear
- b. Measurement - angular
- c. Estimating

Science Processes
- a. Collecting and organizing data

IV. **Materials**

Clinometers - Student worksheet, page 2, run on tagboard or glue to cardboard
Strings marked in meters or meter tapes (15-30 meters long)
Student worksheet, page 3 and tangent table, page 24

V. **Key Question**

"How tall are various objects on our campus?"

VI. **Background Information**
1. The height of perpendicular objects can be calculated using the laws of trigonometry.
2. If you know the distance from your sighting point to an object and the angle from the ground to the top of the object, you calculate the height of the object by multiplying the tangent of that angle times your distance from the object.
3. The clinometer is the tool which gives you that angle.
4. If you are 15 meters from an object, you can measure the angle and use the water rockets' altitude chart (student page 24) to calculate its height.
5. If the student using the clinometer is standing up, you must add the height from his eye to the ground, to the height calculated from the tangent table.
6. Objects such as flag poles and pointed trees are easier to sight than rounded trees.
7. For maximum accuracy, students must sight directly along the top of the clinometer.

VII. **Management Suggestions**
1. Estimated time - 30 to 40 minutes, depending on number of objects being measured.
2. Divide class into groups of 4 to 6 students.
3. Each group needs a clinometer, string or tape measure and student data sheet (page 2 and 3 of student book).
4. Students can rotate through the jobs of clinometer sighter, clinometer reader, data recorder and distance measurer.
5. Have students sight clinometer close to the ground by crouching or lying down; otherwise, they will have to add their heights to the calculated height of the object.
6. Have objects to be measured clearly marked beforehand. Students can rotate from one object to the next.
7. While outside, students should only record the angles of the objects. They can calculate the heights from the tangent table after they return to the classroom.

VIII. **Procedure**
1. Assign groups to objects to be measured and explain rotation procedure.
2. Groups will proceed to their first object and estimate its height, recording their estimate on the worksheet. Then they will use the string or tape measure to find their sighting point. They will record this distance on their worksheet.
3. The clinometer sighter will get close to the ground at the sighting point (he may lie or kneel down), and sight along the clinometer to the top of the object.
4. The clinometer reader will read the angle from the clinometer, and the recorder will record the angle on the worksheet. Then the group will move on the next object.
5. Repeat the above procedure until all groups have collected their data.
6. Return to the classroom and calculate the heights of the objects by using the tangent table. Record the heights on the worksheet and check to see how close the estimates were.

X. **Discussion**
1. What good is this? How else can we use it? (Measure altitudes of objects in the sky; measure heights of distant objects.)
2. Why did your teacher tell you to lie down or kneel when you measured the angle? (When standing, your height must be taken into consideration when calculating the altitude of the object.)
3. A wonderful activity for early in the year would be creating "measuring devices," which will be used throughout the year. Take heavy string and have students mark off meters--mark on it darkly! (30 to 50 meters should be long enough.) Then label every 5 meters, using masking tape and indelible markers. Wrap the strings around a box, or can, or large spool for storage.

How High Can You Throw?

I. Topic Area

Gravity

II. Introductory Statement

Students will determine the amount of time it takes a thrown ball to hit the ground.

III. Math Skills

a. Measurement
b. Using formulas ($s = \frac{1}{2}gt^2$)
c. Timing

Science Processes

a. Collecting and organizing data
b. Observing
c. Applying and generalizing

IV. Materials

Stopwatch
Ball or other object to throw into the air
Student page 4

V. Key Question

"How high can you throw?"

VI. Background Information

1. In this investigation, students will determine the height of a thrown (or batted) object using time and the laws of gravity as the tools for measurement.
2. While an object is in the air, half of the time it is rising and half the time it is falling back to earth.
3. During the first half, the force of gravity is slowing the ball at the same rate that it will speed up the ball as it returns to earth.
4. Using a stop watch is a useful mathematical, scientific, and real-life skill, which many students have not had an opportunity to develop. First, since the stop watches are used so often in these activities, try to obtain several for the students to use. Second, allow them time, preferably near the beginning of the year, to practice; you might have them time a number of simple, everyday school tasks such as getting in line for lunch, taking out their books and finding the right page, and so forth. You might even end up with a classroom of students who are quick and efficient!
5. Caution: Student(s) working on this investigation should pick an open area, away from crowds. Each person should pay strict attention to the flying object)s) to prevent possible injury.
6. For younger students, multiply by 5 meters instead of multiplying by 490 cm and dividing by 100.

VII. Management Suggestions

1. This will take a minimum of two 45-50 minute periods.
2. This could be a large group investigation but works best in groups of three to six.
3. Never throw sharp or dangerous objects.
4. You may want to assign specific jobs to each student in each group, i.e., Timer, Recorder, Thrower, Observer, etc.

VIII. Procedure

1. Select an area away from buildings and people.
2. Timer will make ready with the stopwatch. At the timer's command, the thrower will throw the object into the air.
3. The timer will time the throw from the time the ball leaves the thrower's hand until it hits the ground.
4. The timer will announce the time of the throw, which is then recorded on the student data sheet.
5. Repeat as necessary to complete student data sheet.
6. Do calculations to determine distances.

IX. What the Students Will Do

1. Collect data for student chart (time).
2. Do calculations to complete student chart.

XI. Extension(s)

You may extend this investigation by changing the shape or size of the object. A clinometer may be used to determine the altitude.

UNBELIEVABLE FLYING OBJECTS

I. Topic Area

Geometric constructions and flying shapes.

II. Introductory Statement

We will construct various symmetric shapes using rulers, compasses, and protractors and explore their flight properties.

III. Math Skills

a. Using a ruler
b. Using a compass
c. Using a protractor
d. Geometric construction
e. Linear measurement
f. Angular measurement

Science Processes

a. Observing
b. Identifying and controlling variables
c. Inferring and predicting

IV. Materials

Rulers
Compasses
Protractors
Scissors
Tag board (or other similar material) cut in 6 inch (15 cm) squares (enough for 3 per student)
Student page 5

V. Key Question

"What effect does the shape, number of blades, size or material of construction have on the flight of a spinning object?"

VI. Background Information

Air makes the spinning object tilt upward as it moves along. Then, it begins to slip on the air and, if it has point symmetry, come back quite close like a boomerang. An object with point symmetry will be balanced around a central point.

VII. Management Suggestions

1. The time to do this activity takes anywhere from 20 to 50 minutes, depending on the ability of students to use rulers, compasses and protractors for construction.
2. Proper use of rulers, compasses and protractors should be taught before this activity.
3. Have students study figures 1, 2 and 3 on student page 5 to get an idea of what the UFO's look like.
4. These shapes can be constructred separately on different days, or all together on one day.
5. The shapes can be constructed as a whole class activity with the teacher using an overhead projector and doing the constructions step by step with a transparent ruler and protractor and a compass with an eraser on its point.
6. Younger students can have the shapes dittoed on tag board or construction paper and simply cut them out and fly them.

VIII. Procedure

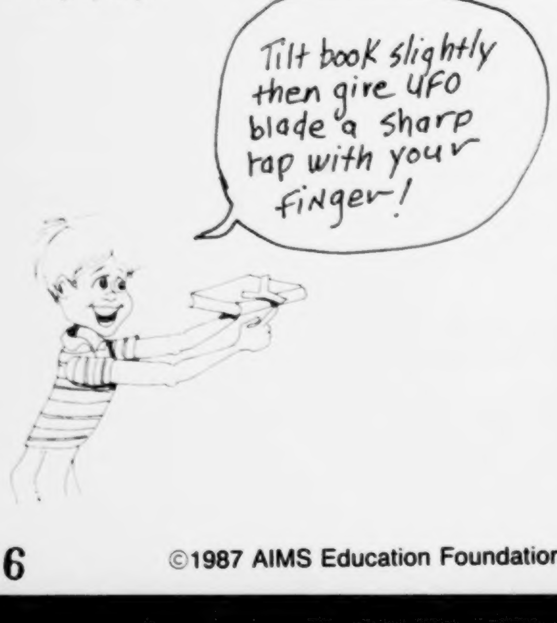
1. Construct the first shape (for step by step construction information see the following page) on 6 inch (15 cm) square piece of tag board.
2. Cut out the shape and place it on a book with one blade extending over the edge (see diagram on student page 5).
3. Tilt the book slightly upward and give the blade a sharp rap with a pencil or your finger to impart a spinning motion.
4. Observe what happens and predict how the second shape will fly.
5. Construct the second shape and launch it. Were your predictions correct?
6. Construct and fly the third shape.
7. Based on the experiences gained by building and flying the first three UFO's, some students may be ready to construct more shapes of different dimensions, shapes, number of blades or construction material.
8. Have them predict and test the effects of these changes (variables) on the flight of their UFO's.

X. Discussion

1. Why do the UFO's fly? (The spinning blades create lift, just like the wing of a plane or a helicopter's rotor).
2. Does the angle of launch affect the flight path of the UFO?
3. What is the flight path when the UFO is spinning counterclockwise? Clockwise? Why?
4. What effect does changing the number of blades, size, shape, etc., have on the UFO?

XI. Extension

1. Have students color the UFO blades and observe the color mixing effect (this is similar to the spinning color wheel).
2. Try and find the shape that boomerangs best.
3. Have students identify blade angles as acute, right or obtuse.
4. Have students find and mark lines and points of symmetry on their UFO's.
5. Have students write and/or illustrate the construction procedure of either agiven pattern or their own design, step by step.


Tilt book slightly then give UFO blade a sharp rap with your finger!

Construction of figure 1. A ruler construction.

1. Find the center of each side of the 6 inch (15 cm) square piece of tag board and mark.
2. Draw 2 perpendicular lines connecting the marks on opposite sides.
3. Draw parallel lines on either side of the 2 original lines, 1 cm away, forming blades 2 cm wide.

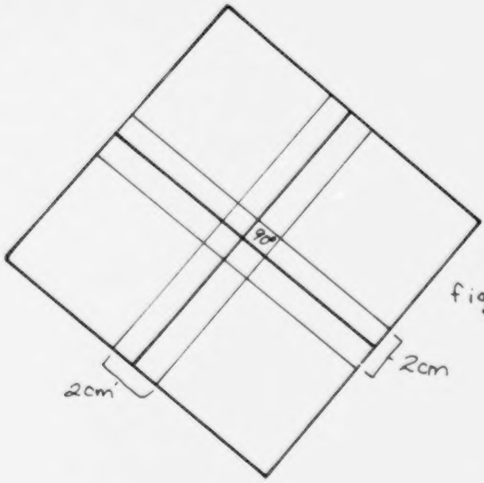


figure 1

Construction of figure 2. A compass and ruler construction.

1. Spread the point and pencil end of a compass 7 cm apart using the ruler as a measure.
2. Find the center of a tag board square (eyeball it or use a ruler) and put the point of the compass there. Construct a circle with a radius of 7 cm.
3. Make a mark anywhere on the circle. Using the radius of the circle as a measure, put the point of the compass on the first mark and make another mark on the circle with the compass. Move the compass point to the new mark and repeat the process until you have 6 marks on the circle.
4. Draw a line from the center of the circle to one of the marks on the circle. Going clockwise from that line, skip one mark and draw a line from the center of the circle to the next mark. Continue clockwise from this new line skipping one mark and drawing your final line. You now have 3 lines about 120 degrees apart.
5. Make 3 blades 2 cm wide by constructing parallel lines on both sides of the 3 original lines, 1 cm away.

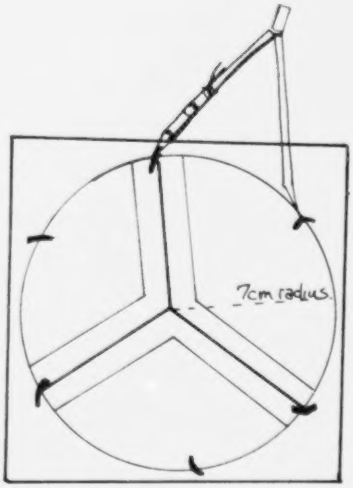


figure 2

Construction of figure 3. A protractor & ruler construction.

1. Find the center of the top edge of the square and mark it.
2. Draw a line straight down from the mark 7.5 cm long and make a dot at the end.
3. Put the center point of the protractor on the dot and align it with the line you drew. It should be on the right side of the line.
4. Find the 120 degree point on the protractor and make a dot. You will be using the outside scale.
5. Connect the two dots with a line 7.5 cm long using your ruler.
6. Rotate the protractor so that it is on the left side of the original line and the center point of the protractor is on the center dot. Align the protractor and mark the 120 degree point. It will be on the inside scale this time. Draw another line as in step 5 above.
7. Draw parallel lines on both sides of the three original lines, making blades 2 cm wide.

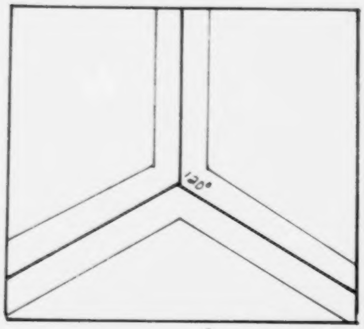


figure 3

More Unbelievable Flying Objects

I. **Topic Area**

Line drawings and flying shapes.

II. **Introductory Statement**

The students will construct several line drawings and explore the flight characteristics of the resulting shapes.

III. **Math Skills**
- a. Use of a ruler
- b. Geometry
- c. Symmetry

Science Processes
- a. Observing
- b. Predicting

IV. **Materials**

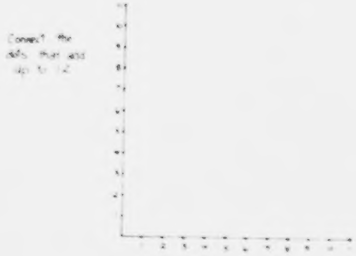
Student pages 6, 7 (run off page 7 on tag if possible)
Additional tag board or other similar material
Rulers
Scissors

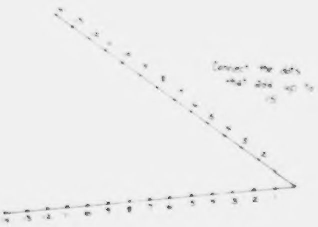
V. **Key Question**

"What do you predict will be the flight characteristics of the shapes you construct?"

VI. **Background Information**

1. Line drawings use pairs of points connected by line segments to approximate a curve.
2. If the sets of dots converge in an angle, the drawing will be symmetrical around the bisector of that angle (Fig. 1). Drawings can also have point symmetry (Fig. 2).





3. For further inspiration, please see the listings in the **Bibliography** at the end of this volume.

VII. **Management Suggestions**

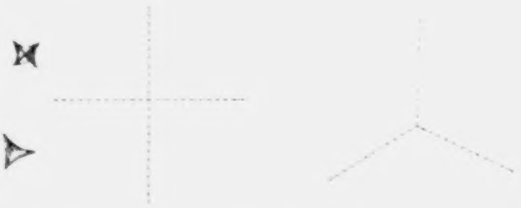
1. This activity takes approximately 30-40 minutes.
2. Student page 6 should be done as a practice activity before working on page 7.
3. Completed line drawings may be used as examples to help students visualize the process.
4. Young students may be started on line drawings by using a geoboard and rubber bands.

VIII. **Procedure**

1. Have students work with geoboards or do the first student page (p. 6) to become familiar with the line drawing process.
2. If possible, have student page 7 run off on tag board. If this is not possible, the drawing can be done on regular paper and the outline traced onto tag afterwards.
3. Using a completed line drawing as an example, have students do the line drawings.
4. Cut out the line drawing if it is on tag board; otherwise, trace its outline onto the tag and cut it out.
5. Have students predict the flight characteristics of the line drawings based on their experiences with flying shapes in the previous activity (Unbelievable Flying Objects).
6. Fly the line drawings using the same procedure as before.
7. Observe and see if the predictions were correct.

X. **Discussion**

1. Follow the same general questions as you covered in the previous activity.
2. Where are the lines of symmetry in the two drawings? Where is the point of symmetry?

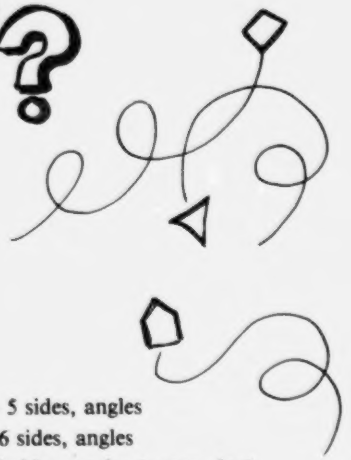


3. Is it possible to make an assymmetrical shape which will fly? Is it possible to make a shape which will fly which just has line symmetry?

XI. **Extension**

1. Have students create their own line drawings.
2. Color in the line drawings and create new ones as an art activity.
3. Try to make much larger drawings and see whether they fly.
4. Use thread and needles on cardboard to make string art.
5. Try to fly some of the line drawing shapes that don't have symmetry.

....But Will It FLY?



I. **Topic Area**

Polygons

II. **Introductory Statement**

Using popsicle sticks as a construction material, students will explore the characteristics of a variety of polygons.

III.

Math Skills	**Science Processes**
a. Identifying geometrical shapes	a. Recording data
b. Measuring angles	b. Describing and "diagramming"
c. Using formulas	

IV. **Materials**

Popsicle, or craft sticks--about 20-25 per student. (Don't use coffee stirrers--they are too stiff.) Junior Tongue Depressors may work.

Drawing paper or graph paper

Student pages 8, 9, 10

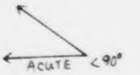
V. **Key Question**

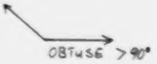
"Can you construct a polygon that will fly using only popsicle sticks?"

VI. **Background Information**

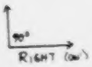
This activity can involve very little, or a great deal of technical information, depending on the grade level of your students, the time available, and your expectations. (Students can handle a great deal of apparently complex material if they discover it themselves.) The basic goal of the investigation is to acquaint students with the names and basic features of "standard" polygons. Some terms which may be necessary or helpful in your discussions are listed below. More detailed, advanced information can be found on the supplementary page which follows this section.

1. polygon - a many-sided, geometric figure
2. closed figure - all sides meet to enclose a finite space
3. regular polygon - all sides and angles are congruent, or equal in measure
4. vertex - point at which two sides of a polygon, rays of an angle, meet
5. acute angle - measures less than 90°, but more than 0°
6. obtuse angle - measures more than 90°, but less than 180°



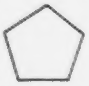


7. right angle - measures 90° (made by perpendicular lines)

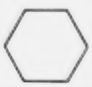


8. triangle 3 sides, 3 angles
9. quadrilateral 4 sides, angles

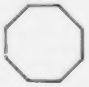
10. pentagon - 5 sides, angles
11. hexagon - 6 sides, angles
12. octagon - 8 sides, angles (a stop sign)



Pentagon



Hexagon



Octagon

VII. **Management Suggestions**

1. Allow 30 minutes for initial exploration. Then allow 40-60 minutes for the student activity (Student page 8). Other student activities (Student pages 9, 10) will also take 40-60 minutes, if you decide to do them.
2. Divide the class into pairs from the beginning. Each student will construct his own polygons, but testing will be easier in pairs.
3. Use a large, open area for constructing polygons if possible--the sticks will pop out at first. Warn students to be careful.
4. Allow one day, or period, at least for free exploration and experimentation. There is skill involved in making these, and practice will help.
5. Emphasize that they cannot use tape or glue, but they must be able to pick up the figures they make.
6. When you are ready to fly the polygons, use a large area as they will probably fall apart, and you don't want students to be hit with flying sticks.
7. Lay out a line from which to launch polygons, so it will be easy to measure and compare the distance each travels.

VIII. **Procedure**

1. On the first day, tell students that a polygon is a "figure with many sides," and that they are going to build polygons using popsicle sticks. Have students volunteer to draw example on the board. Discuss what makes a figure a polygon--a dog isn't; a triangle is--and eliminate those which are not closed, geometric figures.
2. As students begin experimenting, answer questions that come up, but do not feel that you have to offer elaborate explanations or detailed information. Students do not have to know everything--names, e.g.,--before they begin.
3. Have students work through the first Student sheet, drawing their polygons. Then, worry about whether the students can name the figures they have made.
4. The other Student pages can be used if you feel your class can handle them, or a few, interested students could work on them independently.

IX. What the Students Will Do

1. Construct and sketch polygons using popsicle sticks.
2. Learn to identify the figure by their geometrical names. Learn how many sides and angles each figure has (Student Sheet #1).
3. Investigate the angles of polygons--size, type (Student Sheet #2).
4. Fly polygons and record data including the distance of the flight (Student Sheet #3).

X. Discussion

1. For the most part, discussion should be guided by student questions and comments.
2. Most areas of discussion are documented on student pages.

XI. Extensions

1. Construct a quadrilateral as before. How many other figures can you name by adding other shapes to it? Sketch them. Count and record the number of sides and braces needed. Test them in flight. What effect do the additions have?
2. Work out the areas of all your polygons by sketching them on graph paper and by using available formulas.
3. Do convex or concave polygons fly better? Test your hypothesis.
4. Do symmetrical or assymetrical polygons fly better? Test.
5. What happens if you "fence" your basic shapes--using more than one stick in the center?
6. Is there a way, still without glue, of increasing the stability by doubling the layers of sticks?
7. What happens if you do glue or lash the sticks? Which one flies better?
8. Will covering the frame of the polygon make it fly better?
9. Try the same activity using tongue depressors. Does it work?

Supplementary Background Information . . . But Will It Fly?

A. 1. Polygons are many-sided figures. Regular polygons have all sides and angles equal (≅ congruent).

2. Triangle: 3 sides; sum of interior angles = 180°; no diagonals.
   Equilateral Triangle: equal sides and equal angles; all angles = 60°.
3. Quadrilateral: 4 sides; sum of interior angles equals 360°; 2 diagonals. N.B.:
   - a. Parallelogram: opposite angles equal; opposite sides parallel (||) and equal.
   - b. Rectangle: 4 right angles; opposite sides congruent and parallel.
   - c. Square: 4 90° angles; all sides equal; opposite sides parallel.
   - d. Rhombus: 4 equal sides; opposite angles equal.
4. Pentagon: 5 sides; sum of exterior angles = 360°; 3 diagonals. In regular pentagon, interior angles are 108°; exterior angles measure 72°.
5. Hexagon: 6 sides; sum of exterior angles equals 360°; 4 diagonals. In regular hexagon, interior angles each measure 120°; exterior angles measure 60°.
6. Octagon: 8 sides; sum of exterior angles = 360°; 6 diagonals. In regular octagon, interior angles each measure 135°; exterior angles measure 45°.

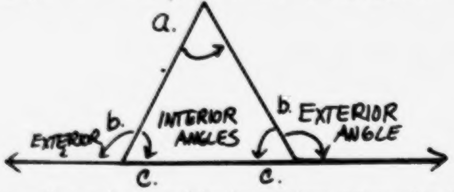
B. Formulas:

1. Angles et al: in a polygon of n sides,
   - a. $n-2$ = number of diagonals
   - b. $\frac{360}{n}$ = measurement of an exterior angle
   - c. $\frac{180(n-2)}{n}$ = measurement of an interiorangle in a regular (or 180 - measurement of exterior angle)
   - d. $\frac{360}{n}$ = measurement of central angle

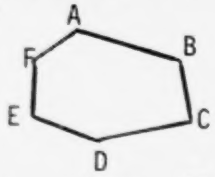
Areas: B = base, h = height or altitude, s = side
- a. Triangle: $A = \frac{1}{2}Bh$
- b. Rectangle: $A = Bh$ (1w)
- c. Parallelogram: $A = Bh$ (However, stress the fact that the altitude is not congruent to the length of the side.)
- d. Square: $A = s^2$

C. Miscellaneous:

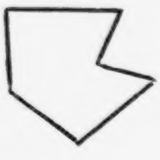
1. congruent ≅ parallel || perpendicular ⊥ right angle ∟
   angle ∠ m∠a = measurement of angle a
2.



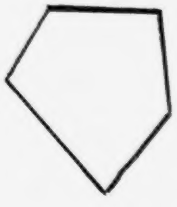
3. A polygon is named by its vertices. Thus, this figure is ABCDEF.



4. This is a concave polygon:



This is a convex polygon:



BE A ROTOR PROMOTER

I. Topic Area

Toy helicopters--A.K.A., paper rotors, twisters, or windmill helicopters

II. Introductory Statement

Students will investigate the behavior of a paper rotor, testing for both the rate and accuracy of the fall, and will examine ways in which the behavior can be altered.

III. Math Skills

a. Measurement
b. Using formulas - $r = \frac{d}{t}$ or $S = r \cdot t$
c. Constructing, interpreting tables

Science Processes

a. Predicting
b. Observing, predicting
c. Manipulating variables

1. Construct the two versions of the twister using the given patterns.
2. Time the fall of the two models using a stopwatch. Record the data. Compute the rate of fall in centimeters per second using the formula $S = r \cdot t$ or $r = \frac{d}{t}$

IV. Materials

Rotor patterns from Student Pages
Other types of paper-file cards, construction paper, etc.
Scissors
Rulers and measuring devices such as metric tape, meter stick, or marked string
Stopwatch(es) - one for each pair or group of students if possible
Target(s) - to be constructed; see Student pages 11, 12, 13

V. Key Question

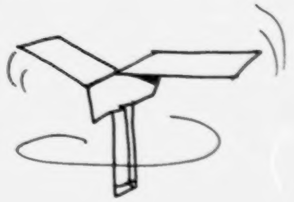
"How does a paper rotor or twister behave, and how can the behavior be altered?"

VI. Background Information

Helicopters are really airplanes with moving wings in which the usual airplane wing and propeller are replaced by a large horizontal rotor. The helicopter rises because the rotor blades push down against the air.

As these paper models fall they will spin, imitating the rotation of the rotor blades of a real helicopter. They will not rise since there is no input of power, but the spin will reduce the rate of fall because it increases the lift.

The behavior of the twisters can be altered by changing: (1) the type of paper used; (2) the size of the twister made using the same proportions; (3) the position of the rotor blades (the pitch, or angle in relation to the shaft); (4) the design of the twister; and (5) the height from which the twisters are dropped.



In testing their twisters, students will be able to compute the rate of fall in centimeters per second using the formula $S = r \cdot t$, or $r = \frac{d}{t}$, where S and d stand for the distance of the fall, t is the time in seconds, and r is the rate of fall.

VII. Management Suggestions

This investigation breaks down into three logical sections: (1) construction of the two basic twister designs, for which patterns are given; (2) testing of the two models for the rate of fall and the accuracy of the fall; and (3) construction and testing of individual designs in which students change the independent variables. It can be done in 2 or 3 class periods of about 40 minutes each.

For all tests, the height from which the twisters are dropped should remain constant. 150 cm is a convenient height. However, you may find it possible and desirable to use a greater height, distance of fall.

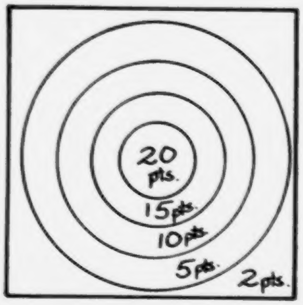
If students work in pairs, one can make each of the versions for which patterns are given, and they can compare the results of their tests using Student Sheets. Two, three, or four pairs of students can be grouped together to use one stopwatch and one target if you wish.

You may want to have a supply of paper clips available in case the twisters seem to need added weight at the bottom of the shaft.

Targets can be easily made by a few students (they will be useful for other activities as well). Use a piece of poster board (22 x 28"); draw 4 concentric circles (r = 2", 4", 7", 10"); label for points.

TARGET
Students can paint these.
Laminate if you wish

Have students identify which pattern they are using by nameing their "helicopters."



VIII. Procedure

1. Construct targets.
2. Determine height from which copters are to be dropped. Find a way to insure that this is consistent, and not influenced by the height of the student.
3. Divide class into pairs for construction and group the pairs for testing.
4. After initial testing, discuss what factors can be changed and allow for creative experimentation with new designs.

XI. What the Students Will Do

1. Construct the two versions of the twister using the given patterns.
2. Time the fall of the two models using a stopwatch. Record the data. Compute the rate of fall in centimeters per second using the formula $S = r \cdot t$ or $r = \frac{d}{t}$
3. Test the models for accuracy using a target placed on the floor and tallying points.
4. After discussing the behavior of the twisters, design and construct other twisters using the material, size and proportions, rotor position, and design of their choice.
5. Test their original models and record data individually or on group graph or table.

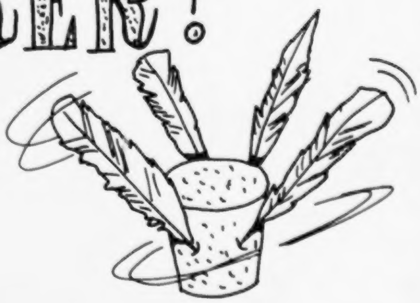
X. Discussion

1. How does the twister behave? (You might drop a model in which the rotor blades have not been bent back to stimulate discussion.)
2. Which version is best?
3. Do the twisters always rotate in the same direction? (Try bending the rotors and flaps in different directions.)
4. What happens if you change the angle at which the blades are bent?
5. What happens if you shorten the blades?
6. What will happen if you change:
   a. the size;
   b. the proportions;
   c. the material used?

XI. Extension Activities

1. Test identical models dropped from different heights. Graph the results.
2. Test identical models made of different materials. Graph the results.
3. Construct a class graph for each of the given versions, which shows the rates at which they fall.
4. Have a class contest to see who can make the most accurate helicopter.
5. Experiment with "Puddle jumpers," bought in the store, to show the ability of the rotor to rise.
6. Research the history of helicopters. Find out about the various uses in today's world.

IT'S A REAL CORKER!



I. Topic Area

Construction and variations of a cork-and-feather helicopter to maximize air resistance.

II. Introductory Statement

Through experimentation, students will discover how changing the number of rotor blades and the angle at which they are placed affects the rate of fall of a helicopter device.

III. Math Skills

a. Measuring angles
b. Geometry - supplementary angles
c. Using a formula - $S(d) = rt$
d. Averaging

Science Processes

a. Collecting and organizing data
b. Identifying and controlling variables
c. Inferring from data

IV. Materials

Corks:
2-2½" ones should be available from a hobby shop, a hardware store, or a scientific equipment supply house. The long, ½" (approximately) corks from wine bottles work beautifully. Styrofoam spools from thread also work. Another alternative is styrofoam--balls, eggs, or pieces of a long rod all work well. (Test the corks, if possible, before you buy them; some are very dense and do not work well.)

Feathers:
A hobby shop is a good source. Don't get them too big or too fluffy. Or have the students collect bird feathers from the ground (they can try to identify them later, perhaps). File cards and styrofoam from meat trays or McDonald's containers can also be used; pin those on.

Protractors, clinometers with the bottom margin cut off, or cards cut to specific angle measurements

Stopwatch(es)

Toothpicks--to poke holes for feathers

Student pages 14, 15

V. Key Question

"In making a cork-and-feather helicopter, how will changing the number of rotor blades and the pitch of those blades affect the behavior, the rate of fall?

VI. Background Information

The principles behind the "corker-copter" are the same as those behind the paper helicopters. However, students will be manipulating two independent variables--the number of rotor blades used and the angle, or pitch, at which they are placed. If the corks are of the same size and weight (or whatever is used), and if the measurements of the angles are made as accurately as possible, the results of the experiments in design will be more "honest" and more obvious.

VII. Management Suggestions

1. This activity will take two class periods of 40-60 minutes each. It would probably be best to allow some "play" time before doing the formal activity, as students will love the fact that these spin around.
2. Divide your class into groups of four; this will make both construction and testing more effecient.
3. Have each member of the quartet make a different version of the helicopter. Have them mark their "corker-copters" with their names, distinctive designs, or names of the "aircraft."
4. Students should construct their first copter, play around with it, and do the first experiment (Student page 18) on one day, and the second experiment (Student page 19) on the second day. They will want to know why it spins, make it spin faster, see it turn over when it is dropped bottom side up, and all sorts of other things before they can settle down to making them go slowly.
5. Emphasize the fact that the object is to maximize the length of time it takes for the copter to reach the ground. For once, the slowest person wins!
6. If you wish, run a simple class competition at the end with all students dropping their favorite corker-copter simultaneously from the same height. Or capitalize on the interest in the rotation and have a spin-off contest in which students count the number of rotations in a given distance.
7. Be sure to drop them from a definite height such as the school stage, down a stairwell (if there are no nearby classrooms to disturb), or off the playground equipment if it is really calm. These behave somewhat erratically at first and need the distance to calm down.

VIII. Procedure

CONSTRUCTION

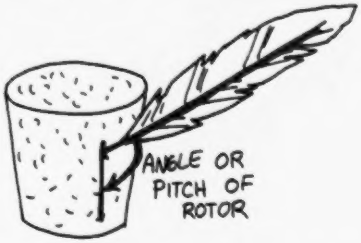
1. Have a model for the students to look at before they begin construction. Do not bring in an optimum design, however, or they won't make an effort.
2. To help in spacing the blades, evenly divide and mark off a short piece of string according to the desired number of blades. Wrap around the cork at desired distance from the top and mark appropriate positions.
3. To measure the angles for part B (Student page 15), it may be easier to use pre-measured and pre-cut pieces of tag board than to use a protractor directly (See Figure 1).

DAY ONE:

1. Have students predict whether 2, 3, 4 or 5 blades will create the best helicopter.
2. Once students have constructed their models (one of each type for each group), they will test their predictions by dropping each version from the same height. They will time the drop to the nearest tenth of a second if possible and determine the rate of fall using an average of 3 trials.

DAY TWO:

1. Have students predict what angle the blades should be set at to produce the best fall. Some suggestions might be those shown below:



Notice that these are supplementary angles; they can be measured whichever way is easiest.

2. As before, students will produce corker-copters the blades of which are set at different angles. Make sure that all students use the same number of blades and that each group has selected a variety of angles.
3. Test as before to determine the optimum pitch of the blades.
4. If time permits, have students combine the results of both experiments and make a final, definitive version.

IX. What the Students Will Do

1. Day One: Construct "corker-copters," which have 2, 3, 4 or 5 rotor glades. Test the various designs, record data, average the times of fall, and determine the rate of fall for each version.
2. Day Two: Construct "corker-copters" using the number of blades selected from Part A; adjust the angle or pitch of the blades. Test the various designs, record data, average times and determine rate as above.

X. Discussion

What is the best design for a corker-copter? Why? What happens with other versions?

XI. Extension

1. Use different sizes and weights of corks. Use different rotor materials.
2. Make a class record or graph of test results.
3. Compete against a commercial shuttlecock!

Ah CHUTE!

I. **Topic Area**

Parachutes

II. **Introductory Statement**

Students will construct various parachutes and calculate their rates of descent.

III. **Math Skills**

a. Measuring time
b. Measuring distance
c. Calculating rate of descent
d. Averaging

Science Processes

a. Collecting data
b. Organizing data
c. Inferring

IV. **Materials**

Cloth, plastic, handkerchiefs, etc.
String or thread
Scotch tape
Washers, metal nuts, various weights
Stopwatch(es)
Meter tapes or equivalent
Step ladder, school stage or the steps of monkey bars or a slide
Student page 16

V. **Key Question**

"What is the rate of descent of your parachute?

VI. **Background Information**

A parachute is a simple canopy (1) which traps and holds air, and gradually lets it escape to bring a payload (3), an object which is tied to its shroud lines (2), safely to earth.

Since students will be calculating the rate of descent for the parachutes they construct, remember that d = rt. The students will be dividing the height from which the parachute is dropped by the time (to the nearest tenth of a second) it took to touch ground, to obtain a rate in meters per second.

VII. **Management Suggestions**

1. The construction times will vary widely with the age and ability of the students. The testing activity and follow-up will take 45-60 minutes. Total time: about 75-90 minutes.
2. Several days before you want to do this activity, encourage students to bring various types of materials to make a parachute, such as rags, plastic bags, paper, old handkerchiefs, etc. Also, encourage the students to bring kite string or thread and nuts, bolts, washers, or fishing weights to use as payloads.
3. When enough materials have been collected for the activity, have students construct parachutes individually or in a small group. If pressed for time, materials, and/or space, have students construct a parachute at home and bring it to school.
4. For younger students who have trouble tying knots, use plastic for the canopy and scotch tape the shroud lines on.
5. Give students time to test their parachutes before any formal activities are done with them.
6. The formal testing would probably work better if it were done in small groups so that no one has to wait very long. Outside, you will have students dropping the chute, timing the drop and recording the information.
7. Calculators can be used to compute rate of descent since students will be dividing by a decimal fraction (1.8 seconds, for instance).

VIII. **Procedure**

1. Choose a suitable drop site where three drop heights can be marked. 1, 2, and 3 meters work well, but another set of heights can be used. A step ladder, stage, ladder of a slide, or jungle gym would be a good release point.
2. Alternate the jobs of dropping, timing and recording.
3. Drop each chute twice from each height and record results. For a class chart, each student can choose the best of the two drops at each point--the SLOWEST--and record it on the general Class Chart, Student page 55. Remember: "He who lands last laughs longest."
4. Repeat process with other groups until all parachutes have been dropped. Complete Class Chart when everyone is back in the classroom by filling in the rates.

IX. **What the Students Will Do**

1. Make (small) parachutes in the classroom.
2. Test parachutes informally (recess?).
3. Drop parachutes from 3 different heights and record results.
4. Calculate the rate of descent for each drop.
5. Record best results on Class Chart.

X. **Discussion**

1. What things affect the rate of descent? (material, size, payload, height of drop).
2. Did the rate of your chute change from one height to another? Why? (acceleration due to gravity).
3. Select the 5 slowest rates of descent and the 5 fastest from the Class Chart. Have those students display and describe their parachutes. Were there similarities? What can you conclude?
4. How would you modify your parachute to improve its performance?

XI. **Extension**

1. Have a contest a week later with prizes awarded for the slowest descent.
2. Further activities will be found in the second Aerodynamics book.

ROCKET BALLOONS

CHART #1

I. **Topic Area**

Rocket Balloons

II. **Introductory Statement**

Students will learn how a rocket works.

III. **Math Skills**

a. Measurement
b. Averaging

Science Processes

a. Recording data
b. Observing
c. Controlling variables

IV. **Materials**

Sausage-type balloons
Soda straws
Masking tape
String (Monofilament fishing line works best)
Measuring tape or meter stick
Student page 17

V. **Key Question**

"How does a rocket work? What gets it off the ground?"

VI. **Background Information**

1. In this initial investigation, we are going to consider the relationship between the length of the balloon and the distance which it travels.
2. Logically, the more air in the balloon, the longer it will be and, therefore, the farther it will travel.
3. This is an example of Newton's Third Law of Motion: for every action there is an equal but opposite reaction. The backward thrust of the air produces the forward motion of the balloon.

VII. **Management**

1. This activity will take one to two class periods, or 45-90 minutes.
2. Try to have as many different lines strung as possible to use as tracks for the balloons to run on. Hang the strings at student eye level.
3. This activity works best in small groups.
4. Assign jobs which can be rotated: one person to (a) launch the balloon, (b) record the distance, (c) observe and check.
5. If room is limited, you will have to lessen the size of the balloons.

VIII. **Procedure**

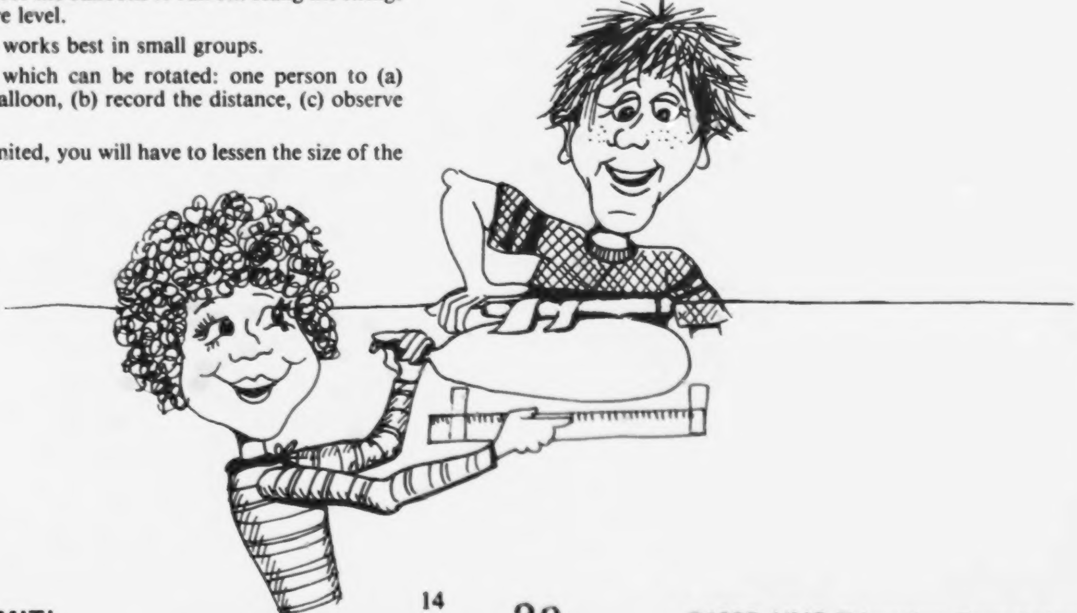
1. As air escapes from the balloon, the rocket will travel along the track (string).
2. Thread string through a straw and attach the ends of the string to a wall or other object. Stretch the string as tightly as possible.
3. Blow up a balloon to the desired size, measure it, and record the data.
4. Tape the balloon to the straw. It is best to tape the soda straw and balloon together near the opening of the balloon, with tape pieces fairly close together.
5. BE CAREFUL--don't let the air out yet!
6. Release balloon. Observe and record the distance it travels.

IX. **What the Students Will Do**

1. Students will make balloon rockets and measure, record the length of the balloon.
2. Students will attach the balloon rocket to the track.
3. Students will measure the distance the balloon travels when it is released.
4. Students will record data.

X. **Discussion**

1. Why does the balloon travel along the string? (thrust: the backward thrust of the released air creates the forward motion of the balloon).
2. What happened as the length of the balloon was increased? (from student observation. Why?) (more air was released).
3. What factors could cause a balloon not to go as far as it should?



ROCKET BALLOONS

CHART # 2

I. Topic Area

Rocket Balloons

II. Introductory Statement

Students will explore the ways in which the angle of ascent might affect a rocket.

III. Math Skills

a. Measurement - linear
b. Measurement - angles
c. Averaging

Science Processes

a. Recording data
b. Observing
c. Controlling variables

IV. Materials

Sausage-type balloons
Soda straws
Masking tape
String (Monofilament line, again)
Measuring tape or meter stick
Protractor to measure the angle of the string--blackboard type?
Student page 18

V. Key Question

"Does the distance a balloon rocket travels change as the angle of ascent increases?"

VI. Background Information

1. Since the balloon will have to travel up the line at an angle, some of the thrust will be expended in this effort.
2. We will be comparing the distance traveled when the rocket is traveling at different angles.

VII. Management

1. This activity works best in small groups and will take 45-60 minutes.
2. Try to have as many different lines strung as possible.
3. Again, assign jobs which can be rotated--a launcher, a recorder and a checker.
4. Hopefully, if students are careful when checking the measurements of the angles when they move the lines, they will also be careful in the physical process of moving the lines.
5. Again, if space is limited, lessen the size of the balloon.

VIII. Procedure

1. Follow Steps 1-6 of the Procedure in part A of this investigation.
2. After each distance is recorded, change the angle of the track the rocket balloon must travel. To measure the angles easily, cut off the bottom margin of a clinometer (Student page 2) and use it.
3. Repeat the above procedure for the different angles of the string.

IX. What the Students Will Do

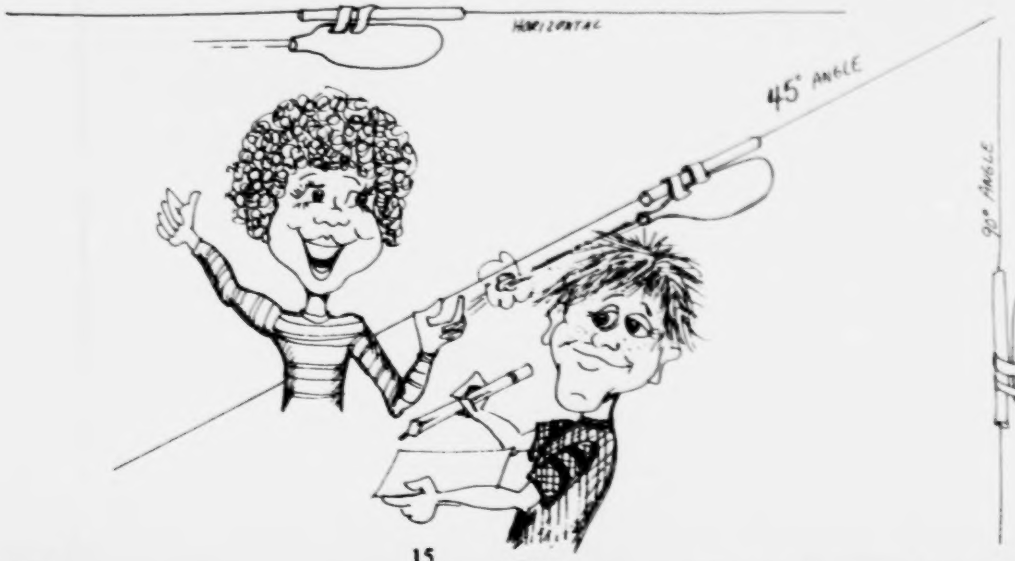
1. After making rocket balloons and measuring their lengths as before, students will measure the distance the balloons travel along the track or line.
2. Students will retest their balloons (blown up to the same length each time) each time that the angle of the track is changed.
3. Students will record the data and compare the distances traveled at each angle.

X. Discussion

1. What happens when the line is changed from level flight to a different angle or flight?
2. Does it take more or less power to lift the balloon rocket "off the ground" when the line is at an angle than it does when the line is level? Why?
3. Does it take more or less power to move the balloon rocket the same distance along an upward path as it does to move it along a level path? Why?

XI. Extension

Students can calculate the speed at which their rocket balloons travel by dividing the distance traveled by the time it took.



ROCKET BALLOONS

CHART #3

I. Topic Area

Rocket Balloons

II. Introductory Statement

The students will investigate the effects on the rocket balloon's flight when its opening is changed.

III.

Math Skills	**Science Processes**
a. Measurement-linear	a. Recording data
b. Measurement-angles	b. Observing
c. Geometry-diameter, circumference	c. Controlling variables

IV. Materials

Sausage-type balloons
Soda straws
Masking tape
Various devices to regulate size of opening in balloons--see Background Information
String (Monofilament)
Measuring tape or meter stick
Protractor or clinometer--see part B
Student page 19

V. Key Question

"How does the size of the opening affect the balloon rocket's flight?"

VI. Background Information

1. We are introducing a new variable here--the size of the opening in the balloon.
2. The greater the opening, the faster the air will escape. One question is whether the increased force of the thrust is great enough to compensate for the shorter length of time that the air is escaping.
3. Different sized openings can be made by taping short pieces of straws inside the end of the balloons; soda straws, MacDonald's straws, and "cocktail sipping straws" would give three variations. You might also try bent paper clips if you watch the sharp ends and roll the mouth of the balloon around the shape created. Wine corks which have been sliced thin and had different sized holes made in them also make good end pieces. Scour the dime store or hardware store for small, lightweight plastic rings of various sizes.
4. Make sure that students are consistent when they measure the openings; establish that they will measure only the inside diameter of the opening. (If you have a pair of calipers rusting in the closet, this might be a fun time to bring them out.) Mention "diameter" and "circumference" if you wish.
5. After students have tested their rockets with the five different openings using the horizontal track, reintroduce the second variable of the angled track. As the angle of the string approaches 90°, perpendicular to the floor, the size of the opening needs to increase to overcome gravitation.

VII. Management

1. As before, this activity works best in small groups, with students rotating the jobs. It will require one to two class periods.
2. Have students experiment with fitting end pieces into the mouth of a balloon before testing as this takes some dexterity. Also, set the standards for measuring the openings and have students practice.
3. Once the students have established the different "mouthpieces" they are going to use, run the activity using only the horizontal line and recording the variations in distance traveled caused by the difference in openings.
4. Discuss the results from the horizontal test with the students. Have them predict the results when the line is set at 45° and at 90°.
5. Run the last two sections of the test changing both the angles of the line and the circumference of the opening.

VIII. Procedure

1. The students will construct rocket balloons as they did before, in parts A and B of this investigation, but they will experiment with creating different-sized, measurable openings at the mouth of the balloon.
2. When they have established the method of making the openings, have them measure the diameter of five "mouthpieces" of various circumferences and record the information of the student page (19).
3. Have students test each of the five "mouthpieces" using a horizontal track and record the results. Make sure that the balloon used is always the same length.
4. After discussing the results obtained on a horizontal flight, ask students what they think will happen on the angled flights.
5. Finally, have students test their rocket balloons using the same "mouthpieces," but on the 45° and 90° tracks.
6. Record all data and discuss the results.

IX. What the Students Will Do

1. Students will make rocket balloons as before, but will also create end pieces which will produce five different openings for their rockets.
2. Students will test their balloon rockets on the horizontal track using each of the five "mouthpieces" successively, and record the results.
3. After discussing the results of that test and predicting what will happen when the rocket balloons are tested at an angle, students will complete the tests for the 45° and 90° tracks.
4. Students will complete the student page by filling in the results of those tests.
5. Comparisons may be made among all the charts. What balloon actually went farthest?

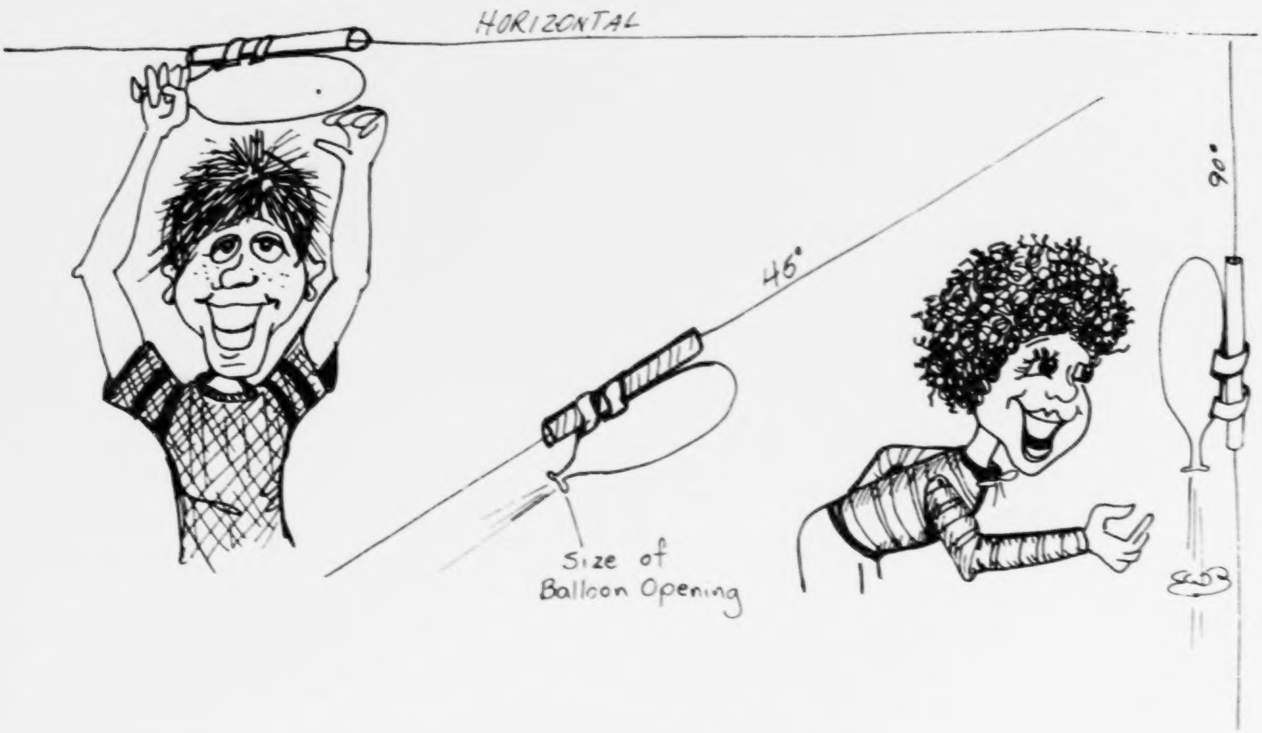
X. Discussion

1. What happens if you decrease the size of the opening of the balloon rocket on a horizontal flight? Why?
2. What happens if you decrease the size of the opening of a balloon rocket on an angled flight? Why?
3. How great was the difference in the distances the rockets traveled? What was the average distance each rocket with the same diameter opening traveled on the same path?

XI. Extension

If students are interested, have them add the variable of different balloon lengths once again. You can challenge them to design the best rocket balloon for each of the three tracks by varying length and the size of the opening.

String two parallel lines and run a relay race. Divide the groups into teams. Have them each mount the first balloon. At the word "Go!", each team releases its first rocket, which will go until it stops. It must then be reblown up and proceed from that point. When it reaches the opposite wall, it must be turned around and started again. When the rocket returns to home base, the second balloon replaces it and "flies" the course, and so on. Students will have to decide for themselves which is the most effective design--opening and length--before the race begins in order to obtain optimum speed and distance in each "heat."



"HOVER CRAFT"

I. **Topic Area**

Balloon Rockets

II. **Introductory Statement**

Students will learn more about how a rocket works, how the force of the engines can be controlled.

III. **Math Skills**

a. Timing
b. Averaging

Science Processes

a. Observing
b. Predicting and estimating
c. Applying & generalizing

IV. **Materials**

Balloons–long and/or round (At least at first, give all students the same size and shape.)
Soda straws
Masking tape
Stopwatch(es) or a watch with a sweep second hand
Ruler or measuring device
Student page 20

V. **Key Question**

"How can you overcome gravity and make a balloon hover in the air in a stable position?"

VI. **Background Information**

This investigation will demonstrate to students how a spaceship may someday land on Earth or how the LEM (Lunar Escape Module) piloted by Neil Armstrong first landed on the moon. Certainly students realize that an object landing in a vertical position must slow its speed so as not to impact the landing area with such great force that severe damage to craft and pilot will result. Here, students will control the escape of air from the balloon in such a way that the force of the thrust will be sufficient only to keep the balloon up, not enough to make it go up.

This is also the principle that is used by the British Royal Air Force in the Harrier Jet (so much in the news recently), a jet airplane that is able to take off or land in a vertical position and may also hover in a stationary position, as a helicopter does.

VII. **Management Suggestions**

1. The size and shape of the balloon can cause differences in the way the balloon will fly. Shape and size may be added later as a variable or extension.
2. The size of the straw (weight and diameter) will affect the flight of the balloon. This may also be added as a variable or extension later.
3. Make sure the straws are taped to the balloon securely so that no leaks exist.
4. Groups of three will work best, with one student to release the balloon, one observer to tell when to start and stop the clock, and a timer. A fourth for recording could be added if necessary.
5. Allow 45-60 minutes for construction, flying, recording and discussion.

VIII. **Procedure**

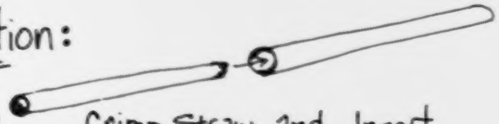
1. Students will need, for each group, at least one balloon, two (or more) straws, masking tape and a timing device.
2. Students need to crimp the end of one straw and insert it into the end of the other straw. This will allow them to adjust the length of the straws.
3. Insert the straw(s) into the end of the balloon and tape with no leaks allowed.
4. With observers at the ready, measure and record the length of the straw, inflate the balloon and release it.
5. The object of this activity will be to adjust the straws in such a way so as to keep the balloon up (in the air) as long as possible.
6. Repeat as desired or necessary.

X. **Discussion**

What does make an aircraft hover? (The force of the engines is constricted until there is only enough force left to overcome the force of gravity on the weight of the craft.)

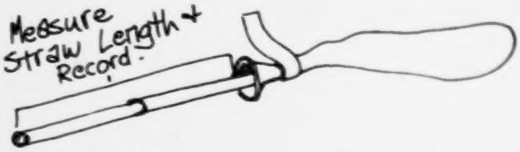
Construction:

1.



Crimp Straw and Insert into second.

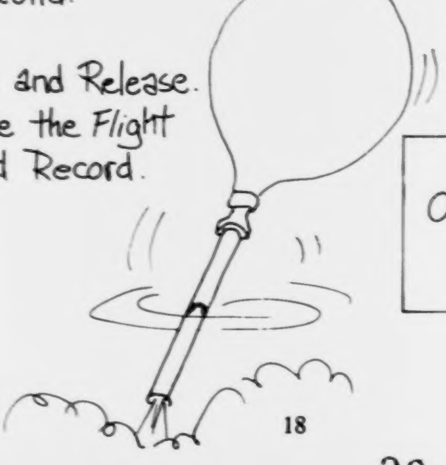
2.


Measure Straw Length + Record.

Insert Straws Into Balloon and Tape - No Leaks!

3.

Inflate and Release. Time the Flight and Record.



What is The Best Length Of Straw For Your Balloon?

WATER ROCKETS

I. **Topic Area**

Water rockets

II. **Introductory Statement**

Through the use of toy water rockets, students will explore the effects of variables on thrust.

III. **Math Skills**

a. Measurement-linear
b. Measurement-angles
c. Using the tangent function

Science Processes

a. Identifying and controlling variables
b. Predicting

IV. **Materials**

Small-sized rocket and pump--from toy, dime or hobby store
Graduated cylinder (50 ml.) or an oral syringe (the type used for measuring medicine; available from most drug stores)
Pail of water
Clinometers, from Student page 2
String - 15 meters long
Student pages 21, 22, 23, 24

V. **Key Question**

"How would varying the amount of pressure and/or the amount of water affect the thrust of a water rocket?

VI. **Background Information**

1. We are dealing with the concept of action versus reaction. In aerodynamics, this is called "thrust," which creates lift by overcoming the force of gravity. The thrust can be measured as it correlates directly to the altitude the rocket attains.
2. The variables are the amount of water in the rocket and the pressure, which is created by pumping. More water makes the rocket heavier; a greater number of pumps creates more pressure.
3. The chart to determine the altitude of the rocket (Student page 21) is based on trigonometric principles. Although knowledge of these principles is not essential to the activity, a basic explanation follows . . . in case (oh, help!) students ask.

   In any right triangle, there are specific relations between the lengths of any two sides. These are determined by the measures of the angles. Considering a, the three sides of a right triangle can be identified as the one "adjacent" to the angle, the one "opposite" the angle, and the "hypotenuse" of the triangle. The three trigonometric functions are sine, cosine and tangent (the one we're concerned with). These express ratios between the lengths of the sides of the triangle as follows:

$$\text{sine} \quad a = \frac{\text{OPPOSITE}}{\text{HYPOTENUSE}}$$

$$\text{cosine} \quad a = \frac{\text{ADJACENT}}{\text{HYPOTENUSE}}$$

$$\text{tangent} \quad a = \frac{\text{OPPOSITE}}{\text{ADJACENT}}$$

A useful mnemonic for remembering these (since they are always printed in the same order in the tables) is, "**O**scar **h**ad **a** **h**eap **o**f **a**pples."

$$\frac{\text{OSCAR}}{\text{HAD}} \qquad \frac{\text{A}}{\text{HEAP}} \qquad \frac{\text{OF}}{\text{APPLES}}$$

$$\frac{\text{OPPOSITE}}{\text{HYPOTENUSE}} \qquad \frac{\text{ADJACENT}}{\text{HYPOTENUSE}} \qquad \frac{\text{OPPOSITE}}{\text{ADJACENT}}$$

$$\sin a \qquad \cos a \qquad \tan a$$

As you can see from the Tangent Table, Student page 24, the tangent is a four-place decimal: if you divide the length of the side opposite an angle (in a right triangle) by the length of the side adjacent to it that is the number you will obtain--as a tangent, it is unique to the measurement of the angle in the triangle, shown in the table. In this activity, we know the angle and its tangent, and we know the length of the adjacent side; therefore, we could find the altitude by multiplying the tangent by 15 meters.

4. For Clinometer use, please refer back to Activity 2, Student pages 2, 3.

VII. **Management Suggestions**

1. Time suggested: one-half hour, orientation; one period (45 minutes) outside; one-half hour or more follow-up time to make charts and graphs.
2. Teacher does the launching following the directions on the box. Prior practice is recommended.
3. Students should work in groups of 3 to 6 and rotate jobs.
   a. Clinometer sighter
   b. Clinometer reader
   c. Data recorder
   d. Observer(s)
4. Groups should be equidistantly space around the circumference of a circle with a radius of 15 meters.
5. Students should have done the activity "How High Is It?," and be comfortable using clinometers.
6. Be sure to keep the pump well oiled.
7. Practice tracking an object thrown into the air and sighting it at its highest point. This will help improve accuracy of readings.

VIII. Procedure

1. Form groups and explain jobs and rotation procedure in the classroom.
2. Collect materials and go outside to an open area.
3. Choose a launch site and use the string to place groups in a circle around it.
4. Use a syringe (or a graduated cylinder and a funnel) to fill the rocket with 10 ml. of water. Pump 5 times.
5. Launch the rocket vertically. (Keep an eye on the rubber gasket as it comes off easily.)
6. Groups will use clinometers to measure the angle of the rocket at its highest point and record that angle on their worksheet (Student page 22 or 23).
7. Repeat process for different volumes and pumps (as suggested on Student page 22). Students can rotate jobs.
8. When all data is recorded, return to classroom to do the calculations.

EITHER

9. After each group has reported its angle for a trial, find the "class average" angle using those figures. Record the averages on Student page 22. Then use the average angle to calculate the altitude from the chart on page 21. Record it for each trial.

OR

10. Use the Student page 23 and the trigometric Table page 24 to calculate the altitudes. Make sure that students record the additional information about volume of water and number of pumps.

IX. What the Students Will Do

1. Students can help with filling and pumping the rocket.
2. Students will observe each launch of the rocket.
3. Students will use clinometers to mark the angle when the rocket reaches its maximum height under various conditions.
4. Students will calculate the altitude of the rocket and discuss the effects of changing the variables of volume and pressure.

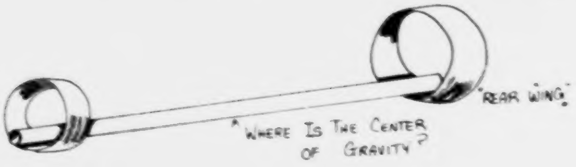
X. Discussion

1. How is thrust affected by increasing the pressure while the volume of water stays the same? (The thrust is increased.)
2. How is thrust affected by increasing the volume of water when the pressure remains the same? (The thrust is increased.)
3. Can you find any ratios relating the altitude to pressure or water volume? (Graphing would help; answer depends on individual results.)
4. What principles of physics have been experienced in this activity? (Newton's Third Law - "For every action there is an equal and opposite reaction.")

XI. Extension

1. Use a blank worksheet to try additional combinations of pressure and water. Can you find an optimum volume of water at a given number of pumps for maximum thrust or altitude?
2. Try the same volume of ice water and warm water at the same pressures. Compare the results.
3. Try a different liquid (salt water or rubbing alcohol) and compare results with those of regular water.
4. Use the formula in the ball throw activity to calculate the altitudes.
5. Use a rubber tube, a container of water and a graduated cylinder to calculate the volume of air in each pump. Compare this to the volume of the rocket. Any conclusions?

It's The Last Straw!


"REAR WING"
"WHERE IS THE CENTER OF GRAVITY?"

I. Topic Area

Loop Airplanes

II. Introductory Statement

Using a straw and two strips of paper, students will make a paper airplane which really does fly. They will use their planes in recording distance, graphing, and in working with the metric system.

III. Math Skills	**Science Processes**
a. Metric measure - cm, dm, m	a. Collecting, organizing data
b. Recording and graphing data	b. Observing
c. Scientific notation, for older students	

IV. Materials

Straws - one per airplane
Patterns from Student Book, page 25
Scotch tape or stapler
Tape measures, marked strings, or even the trundle wheel gathering dust in the closet
Poster board for a class graph, if desired
Student pages 25, 26

V. Key Question

"How far will a loop airplane fly?"

VI. Background Information

The principle joy of this activity is that there is no background information! By some miracle,--or rather, by all those previously discussed miracles such as lift,--this rather off object actually does fly! Enjoy!

In the process of enjoying, have the students practice converting from one metric unit to the others as they measure the distance their planes fly. The student sheet asks for measurements in centimeters and meters; students may be encouraged to make complete charts.

Older students can use this experience to use scientific notation. If the plane flew 2.275 m, show them that the distance can be expressed in other units without changing the number:

$$\begin{aligned} 2.275 \text{ m} &= 2.275 \times 10^{0} \text{ m} \\ &= 2.275 \times 10^{1} \text{ dm} \\ &= 2.275 \times 10^{2} \text{ cm} \\ &= 2.275 \times 10^{3} \text{ mm} \end{aligned}$$

VII. Management Suggestions

Each student will build his/her own plane according to the pattern, but it will be easier to measure the distance flown if students work in pairs. One student will launch his plane while the other marks the distance it flew. Allow 40-50 minutes.

VIII. Procedure

1. You might introduce the activity by showing the students a straw and two loops of paper and asking whether they think a "flying object" could be constructed from them.
2. You might want to consider doing "This is Definitely the Last Straw" first, as the pattern presented here may be difficult to improve on.

IX. What the Students Will Do

1. Each student will construct a loop airplane.
2. Each student will test his plane five times, measuring the distance flown in centimeters, but recording it both in centimeters and meters. (Other units as desired.)
3. Find the average distance flown.
4. Graph the distances flown.

X. Discussion

1. Where is the center of gravity of your loop plane? How do you find out?
2. How and where do you hold your plane to launch it? Why? What happens if you try to fly it the other way around? Why?
3. Is the fact that the straw is hollow important? Try plugging one end. What happens?

XI. Extension

1. Interested students can make a table showing the distances expressed in all the metric units.
2. Make a class graph showing the maximum flight distance for each student's plane. Find the mean, median, and mode of the distances measured.
3. Make a frequency table showing the distances flown (maximum from each student). Determine the range of the set of numbers. Have each student determine the percent of variation from the mean for his plane.
4. Discuss the probability of a plane's falling short of, exceeding the mean distance flown.
5. Use the measurements recorded to work with scientific notation.

This is Definitely
The Last Straw!

I. **Topic Area**

Loop Airplanes

II. **Introductory Statement**

Having tested a loop airplane constructed according to a given pattern, students will now experiment in manipulating the variables of design in an effort to improve the basic design.

III. **Math Skills**

a. Linear measurement
b. Finding circumference, radius
c. Finding averages

Science Processes

a. Predicting
b. Controlling variables
c. Recording data

IV. **Materials**

Straws
Paper - perhaps of different types and weights
Scotch tape
Rulers
Tape measures or similar devices
Student page 27

V. **Key Question**

"How can the basic loop airplane be improved?"

VI. **Background Information**

There are three basic variables involved in the design of this airplane: (a) the size of the loops (both width and length, or circumference); (b) the material used to make the loops; and (c) the placement of the loops. Students can also select either the straw or the folded-paper fuselage, but, to control the variations, should probably stick to one or the other.

Since the circumference of the circle made by the loop is known, challenge students to determine the radius of each loop used. $c = 2\pi r$, so r (radius) $= c/2\pi$. This could be a good calculator activity: use the length of the loop as the circumference (subtract the overlap used for gluing or taping; use $\pi = 3.14$.)

Do not feel restricted to size by the straw length; the folded-paper fuselage allows students to make much larger models.

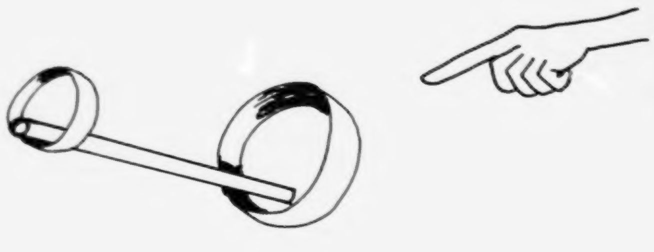
VII. **Management Suggestions**

Encourage students to proceed somewhat logically. They might begin by predicting what would happen if they shortened the fuselage of the prototype model by moving the loops closer together. Allow ample time for hypothesis and experimentation so they can manipulate one variable at a time.

Once each student has developed two models he/she finds satisfactory, test them for distance as before, using partners and allowing five trials.

If desired, when all the serious record-keeping has been done, hold an all-out, one-chance championship match to see which student's loop plane flies the longest distance.

Allow approximately 40-60 minutes for this activity.



VIII. **Procedure**

Depending on your students, you may want to spend some time discussing the variables and speculating on the results of certain changes before the class begins to experiment. Alternatives would be discussing what happened only after all models were completed and tested, or providing some guidance through discussion after some experimentation has occurred.

IX. **What the Students Will Do**

1. By manipulating whatever variables of construction they wish, students will try to improve the basic loop plane.
2. Each student will construct two different models of the loop plane.
3. Students will record all data regarding each of their models, and test each for distance.
4. The class will discuss the results of their experiments and attempt to decide what factors of design influenced performance most positively.

X. **Discussion**

1. Before redesigning the loop airplanes, ask the students:
   a. What could be changed in the design of the loop airplane?
   b. What effect might each change have on the distance the plane would fly?
   c. Can you think of anything you definitely would not want to do to the design of the plane?
2. After redesigning the loop airplanes, ask the students:
   a. What changes seemed to improve the plane most?
   b. Were your predictions accurate?

XI. **Extension**

Consider making a loop airplane using an aluminum rod and tin cans. This might be a class project, particularly if someone has a father who can weld or solder.

First Class Airplanes

Introduction

You are about to embark on another very satisfying and interesting experience in the study of flight. Only you are going to do this without sophisticated equipment and materials, and with little or no expense. Your flying models will be made of paper. Kids of all ages enjoy the art of building and flying paper airplanes; therefore, we can turn this enjoyment into a real learning experience.

In this section, you have been provided with many different paper airplane designs, student worksheets (for data collection), directions, management suggestions, lists of materials, and an extension activity that probably will spill over your classroom to other parts of the building--the Air Fair.

You will start your activities by having each student select and build five different paper airplanes, using designs provided in this booklet (Student pages 28-32), or designs of his/her own. Students may name their aircraft using the guidelines given in the Aviation Alphabet (Student page 37), just as the real planes are named. The next step will involve the actual flying and testing of the five different models, and recording the resulting information on student data sheets. There are four different data collection sheets of flight performances. There is one sheet each for Distance (Student page 33), Duration or flight time (page 34), Accuracy (page 35), and Aerobatics (page 36). Each student will fly all of his/her airplanes for each category, record the data, and determine which airplane is best suited for a particular type of flying. For example, the best distance or accuracy flyer may not be the best stunt plane. As students discover these facts, they will come to understand some interesting aspects and advantages of certain elements of airplane design.

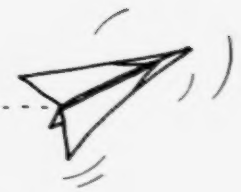
As an extension to this activity, you may want to organize the Air Fair, a paper airplane competition in these four areas, the rules and directions for which you will find at the end of this section.

Good luck and good flying!

Activities 15, 16, 17, 18 and 19 - Student pages 28-39

Distance Data

First Class Airlines



I. **Topic Area**

Paper Airplanes

II. **Introductory Statement**

Students will learn the effects of design on the distance a plane can fly.

III. **Math Skills**
- a. Geometry
- b. Measurement

Science Processes
- a. Observing
- b. Predicting & estimating
- c. Applying & generalizing

IV. **Materials**

Scrap paper (unwrinkled, not too small; mostly 8½x11)
Measuring device (tape, meter stick, or a string marked in appropriate units of measure)
A stake or nail (optional; see "VIII. Procedure")
Student page 33

V. **Key Question**

"How does the design affect the flight of a paper airplane in terms of the distance it flies?"

VII. **Management Suggestions**

1. The teacher should pick a fairly calm day, or use a large indoor space for testing. This can be used as an indoor or outdoor activity; whichever you choose to do, make sure you have planned for a starting line, an efficient way to measure distance, etc.
2. Each student should build five types of airplanes, either selected from this section of Student pages (28-32) or of his/her own design.
3. Variables for flight could be the thickness of the paper used.
4. Before a student finalizes his designs, he may build several planes, so have plenty of paper handy.
5. You may want to do each of the four investigations on separate days, once the students have built their planes. Testing itself should not take more than 30 minutes unless you have a very large class.
6. After individuals have tested their different models, you may want to divide the class into small groups to compare their best versions. Use the table on the bottom of page 33.

VIII. **Procedure**

1. For testing, you will need to have a designated starting line. It is best to have a pre-marked string fixed to the starting line (tied to a stake, if outside), so the students will only have to stretch the string to the landed plane to measure the distance of its flight.
2. The student will approach the starting line and try to fly his airplane as far down range as possible.
3. The student will measure the distance from the starting line to the landed airplane and record the measurement on the student data sheet.
4. Repeat as necessary for all five airplanes until the data sheet is completed.
5. Have students compete in small groups using the model which was most successful of their five.

IX. **What the Students Will Do**

1. Students will build five different paper airplanes.
2. They will test their airplanes for distance and record the data.
3. Optional--They will compare the performance of their most successful plane with those of others in a small group.

X. **Discussion**

Suggest that students think about the special features of the plane which flew the longest distance.

Length Aloft

First Class Airlines

I. Topic Area

Paper Airplanes

II. Introductory Statement

Students will learn the effects of design on the way an airplane flies: how long it will stay in the air.

III. Math Skills / Science Processes

Math Skills	Science Processes
a. Geometry	a. Observing
b. Measurement	b. Predicting & estimating
c. Timing	c. Applying & generalizing

IV. Materials

Scrap paper - as before, unwrinkled, mostly 8½"x 11"
Stopwatch(es) or watch(es) with sweep second hand(s)
Student page 34

V. Key Question

"How does the design affect the flight of a paper airplane--in terms of the length of time it will stay in the air?"

VII. Management Suggestions

1. Follow the suggestions for "Distance Data," numbers 1-6.
2. It is best to have students work together on the activity. While one flies the airplane, the other can be the timer. After each trial, the students may change positions as timer and pilot. If your students are also doing the comparison test in small groups, let each person test his/her planes individually, sharing the stopwatch with the group; then, each can select the best of the five and compete.

VIII. Procedure

1. The "pilot" will launch his airplane at a signal from the timer.
2. The timer will start the stopwatch the instant the plane is launched, and stop it when the plane hits the ground.
3. Both the timer and the pilot should read the time of the flight and record it on the pilot's data sheet.
4. If a watch with a second hand is used, the timer will have to read the time as accurately as possible.
5. Continue the process until all five airplanes have been tried and the data sheet is complete.
6. When the data chart is complete for the pilot, he will switch with the timer and they will repeat the process.

IX. What the Students Will Do

1. The students will test the five paper airplanes they have constructred to find out which one will stay in the air for the longest time.
2. Students will complete the data sheet (Student page 34).
3. Students may use their best model to compete in small group comparisons.

X. Discussion

1. What features characterized the planes with the longest times aloft?
2. What features were different from those of the planes which flew the longest distances?

On Your Mark - Accuracy

I. **Topic Area**

Paper Airplanes

II. **Introductory Statement**

Students will learn the effects of design on the way a paper airplane flies: how accurate it is.

III. **Math Skills**	**Science Processes**
a. Geometry	a. Observing
b. Measurement	b. Predicting & estimating
	c. Applying & generalizing

IV. **Materials**

Scrap paper as before - really, the same five planes
Measuring device (tape, meter stick, or string marked in appropriate units of measure)
A stake, a baseball base, or some appropriate target (if you are doing this indoors, you might use the target from "Be a Rotor Promoter")
Student page 35

V. **Key Question**

"How does the design affect the flight of a paper airplane -- in terms of the accuracy of its flight?"

VII. **Management Suggestions**

1. Follow the management suggestions for the other investigations in this unit.
2. You will have to have a starting line and a target for this activity. The best way to measure for accuracy outside is to stake a string or cord some predetermined distance from a starting line or point. When the pilot lands his airplane, he/she (or a helper, partner) will rotate the string around the center stake and measure the distance from the stake to the airplane.
3. Indoors, you could use some predetermined spot or, as your students get more adept, use the target you made for "Rotor Promoter."

VIII. **Procedure**

1. Have the course laid out before you begin. If you have a large class or limited time, you might set up multiple courses. Some students who finished early in the "Length Aloft" activity might be responsible for setting this one up for the next session.
2. Each pilot will approach the starting point or line and launch his airplane, trying to get it as close to the designated target as possible.
3. Either the pilot or a partner will measure the distance from the target to the landed airplane. The pilot will record the distance on his data sheet.
4. The above steps should be completed with all five airplanes until the record is complete.
5. Again, you may want to have the students compare the flights of their most accurate models by forming small groups.

X. **Discussion**

1. Was your most accurate plane different from the ones that were most successful in the other categories?
2. In what ways was it different?

Train Your Plane

Aerobatics

I. **Topic Area**

Paper Airplanes

II. **Introductory Statement**

Students will learn the effects of design on the way a paper airplane flies: what stunt each type can do.

III. **Math Skills**
- a. Geometry
- b. Measurement

Science Processes
- a. Observing
- b. Predicting & estimating
- c. Applying & generalizing

IV. **Materials**

Each student should have five paper airplanes from the previous investigations
Student page 36

V. **Key Question**

"How does design affect the way a paper airplane flies--what stunts will each type do?"

VII. **Management Suggestions**
1. Keep doing what you have been doing.
2. Give the students time to practice after you have all agreed upon the nature of each stunt.
3. Divide the class into small groups and assign each group an area in which to work.

VIII. **Procedure**
1. Students will try to make each of their five planes perform the assigned stunts indicated on the student worksheet. When each stunt has been attempted by a particular plane, the pilot will mark the appropriate column of his record.
2. Continue to proceed through the worksheet until all spaces have either a positive or negative response.

X. **Discussion**
1. Looking at the planes which were able to do the most stunts, what sets them apart from the other designs?
2. Were the most successful planes in this category successful in other categories? If so, what categories? If not, why not?

XI. **Extension**
1. Have the students draw illustrations on poster board to show what is involved in each stunt.
2. Have them write step-by-step instructions for performing the stunts.
3. Have them write a story about "training" their planes.

Rule: All Planes Must Be Launched Horizonally

This is a BONUS--no tables, graphs, or charts; just make and fly!

There are many unique and amazing designs of paper aircraft. The "Super Tube" offers one of the most amazing flying shapes to come along in quite awhile. If students are asked to guess what is before them, it is seldom that they will think that this is an aircraft, but it's such fun to fly, they will be easy to convince.

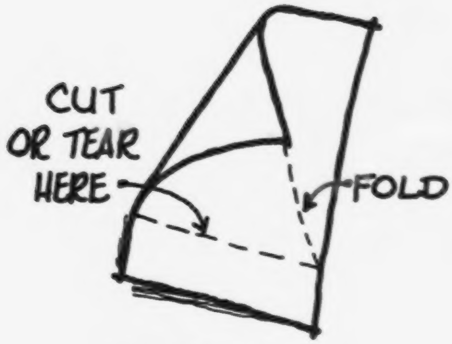
The steps to construct this aircraft are not difficult, but they should be followed fairly closely to assure success. For clarification, see the illustrated page that follows.

Use 8½" x 11" paper

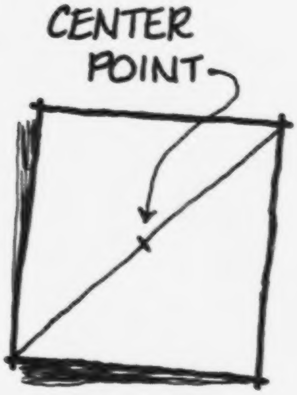
Step 1. Fold corner over and cut off the bottom of the paper to form a square.
Step 2. Measure or crease along the folded edge to find the center point.
Step 3. Open flat and fold one corner of the paper to that center point, as shown.
Step 4. Continue folding to the center (in 1 cm folds) until the fold width meets the center line or diagonal (4 and 5 in drawing).
Step 5. Fold once more past the center line (6 in drawing).
Step 6. This is one of the special steps that insures success! With the fold up, run the paper over the edge of the table several times to establish a curve. (Drawing 7), then tape, staple, or glue the overlapped ends.
Step 7. Hold the "Super Tube" as shown in Drawing 8, and launch with a gentle!!! toss away from you.

ENJOY! ("The best things in life are free!")

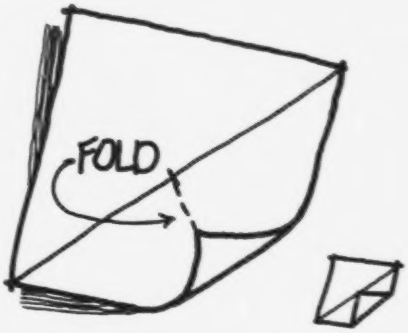
SUPER TUBES


CUT OR TEAR HERE
FOLD

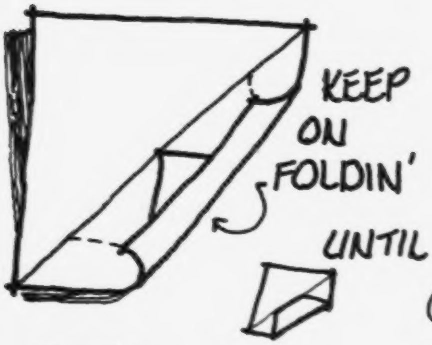
STEP 1


CENTER POINT

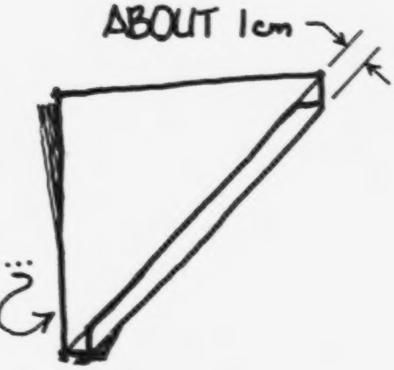
STEP 2



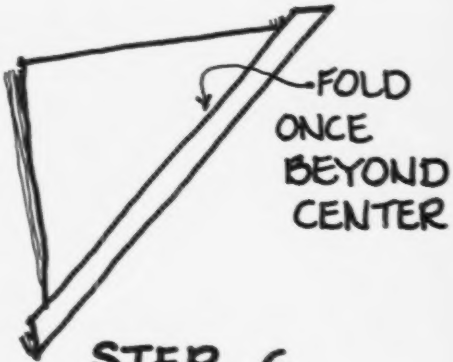
STEP 3


KEEP ON FOLDIN'
UNTIL...

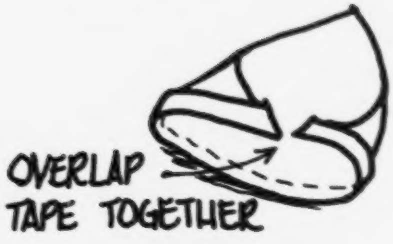
STEP 4



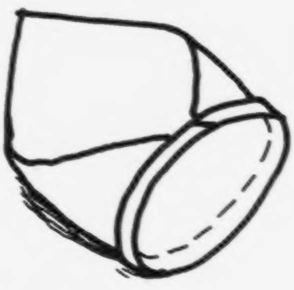
STEP 5

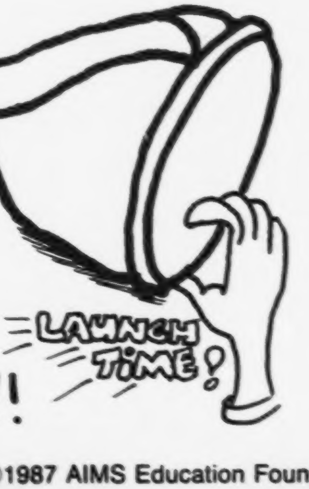

FOLD ONCE BEYOND CENTER

STEP 6


OVERLAP & TAPE TOGETHER

STEP 7




LAUNCH TIME!

`YE OLDE
FINISHED PRODUCT!!

AIR FAIR

Overview, Organization and Rules

The Air Fair will be broken down into four categories: Distance, Duration (flight time), Accuracy, and Aerobatics. Each entrant or pilot will be awarded three points simply for entering each event during the competition. Awards will be made in each category in addition to one grand "prize" for the overall winner who will be the pilot with the largest number of total points.

The Air Fair should be organized in the manner described below.

The contestants will be divided into four fairly equal groups and assigned the numbers one through four. Group one will proceed to the first event (Distance), group two to the second event (Duration), group three to the third event (Accuracy), and the fourth group to the last event (Aerobatics). At the completion of each event, the groups will rotate in numerical order, to the next event: group one to event two, group two to event three, group four to event one, and so on.

Each pilot will be provided with an Official Scorecard which will be presented to the Judge in charge of the event. The Judge will fill in and initial the pilot's card after he has competed.

At the end of the entire competition, each pilot will hand in his/her official Scorecard to the Meet Director who will determine the winners for each individual event and the overall winner.

Organization

Plenty of help will be needed in order to make the meet run smoothly. Suggestions are made in the organization of each event for the number of officials, helpers and the necessary materials required to run the event properly.

Event #1: Distance

Object: To get the longest flight possible

Personnel: Judge, assistant (optional), two measurers.

Materials: Tape measure, meter stick, or string marked in units of measure.

Procedure: With a starting line established, fix the tape or string with a nail, pencil or any sharp object and stretch it down range. Each pilot will step to the starting line, hand his/her Official Scorecard to the Judge. When told to do so, the pilot will launch his/her airplane down range as far as possible. The distance will be marked and measured by the measurers and reported to the Judge who will cord and initial the appropriate spot on the scorecard. Each pilot will have only one try.

Event #2: Duration (flight time)

Object: To have the airplane stay in the air as long as possible.

Personnel: Judge, assistant (optional), spotter and timer.

Materials: Stop watch, or watch with sweep second hand.

Procedure: The pilot will approach the Judge when is his/her turn, hand the Judge the Official Scorecard and wait until told to launch the airplane. The spotter will yell "go" at which time the pilot will launch his/her airplane and the timer will start timing. When the airplane touches ground the spotter will yell "stop" at which time the timer will stop the clock. Time in seconds is reported to the Judge who then records and initials the Official Scorecard and returns it to the pilot. Each pilot will receive only one try.

Event #3: Accuracy

Object: To get as close to a designated point as possible.

Personnel: Judge, assistant (optional), two measurers.

Materials: Pencil, nail or other sharp object, measuring device (tape, meter stick or cord marked in units of measure). The cord marked and fastened to the stake so that the distance from the center post to the airplane may be measured in a full 360° circle is the best way to measure for this event.

Procedure: Each pilot will hand the Judge his/her Official Scorecard and step to the designated starting line some distance from the center post. When the pilot is ready he/she will launch toward the center post trying to actually land on it. The measurers will then rotate the string (or tape) in a direct line with the airplane and measure the distance from the center post to the airplane and report that distance to the Judge who will record and initial the Official Scorecard.

Event #4: Areobatics

Object: To do as many of the assigned stunts as possible.

Personnel: Judge, helper (optional).
SUGGESTION: Depending on the size of your class, you may want to increase the number of officials to speed up the process at this station.

Materials: None

Procedure: One point will be earned each time the pilot causes or makes his airplane do the assigned stunt. Those stunts are in this order on the Official Scorecard:

1. Straight Flight
2. Climb
3. Dive
4. Right Bank
5. Left Bank
6. Loop
7. Double Loop
8. Boomerang

After each try the pilot will retrieve his/her craft (or it will be retrieved by the helper) and make ready for the next stunt by making whatever adjustments to the airplane he/she feels may be necessary. The procedure will continue until all stunts have been attempted. The Judge will then score the Official Scorecard and initial it. Each pilot will get one try for each stunt.

AIR FAIR

Air Fair
Rules

Rule #

1. Have plenty of help!!!
2. Each entrant may enter only one airplane for the entire contest. However, he/she may modify the design for each category in order to make the airplane perform at the optimum capability.
3. In each event, the pilot will automatically receive three points for entering.
4. Each event will have a maximum point total of 10 points for the winner, plus the three additional points for entering, thus giving a total maximum of 13 points. The exception will be areobatics in which one point will be awarded for each stunt the pilot's craft performs satisfactorily.
5. Points will be distributed in the following manner:

   1st place—10 pts.
   2nd place—9 pts.
   3rd place—8 pts.
   4th place—7 pts.
   5th place—6 pts.
   6th place—5 pts.
   7th place—4pts.
   8th place—3 pts.
   9th place—2 pts.
   10th place—1 pt.
6. During the stunt competition, the pilot must launch his/her airplane from a level position (about shoulder height), and will receive one point for each stunt completed.
7. If the pilot fails to obtain the signature (initials) of the Judge for any event, he will be disqualified for that event only.
8. Each pilot will receive only one try in each event and one try at each stunt during the contest, unless the Judge feels it necessary for another try to be granted.

The Whole Kite and Kaboödle

I. **Topic Area**

Construction of paper kites.

II. **Introductory Statement**

We will explore the flight characteristics of three simple paper kites.

III. **Math Skills**

a. Measuring
b. Recording Data
c. Charting
d. Averaging
e. Graphing

Science Processes

a. Observing
b. Predicting & estimating
c. Interpreting
d. Discussing Data

IV. **Materials**

Take a chance! Rob the office! For specific materials, see individual activity numbers 20, 21, 22; Student pages 40, 41, 42 and 43. Also, Student pages 44-50.

V. **Key Question**

"How high can paper kites fly?"

VI. **Background Information**

Part I - General Information

Students almost invariably ask, "How high is the kite flying?" Accurate measurement of a kite's altitude is not easy. A practical solution is possible, however, if you know just two things: how far away the kite is, and second, the angle between the horizon and a line drawn from you to the kite. That line exists, for it is the kite line. If all the line is out, you probably know its length.

With the kite's distance known and the angle of its position, you can refer to Chart A or B to determine the altitude. "Belly" or slack in the kite line affects the accuracy of your calculation somewhat at low altitudes. However, the higher the kite and the steeper the angle, the more nearly equal are the distance and the length of the line.

Part II - Directions for using the ADC (Altitude Determining Card) - Student pages 46, 48

1. To determine the altitutde of a flying kite, cut out and use the ADC. Each student should have his own ADC. These cards can be reproduced on tagboard, card stock, or simply glued to cardboard.
2. Place a small table on a level surface (Student page 45 or 47).
3. Place the ADC on top of the table.
4. With the end of the kite string dangling over the edge of the table (15 cm or 6"), sight kite using a soda straw as shown on Student page 46 or 48.
5. The angle and altitude can be determined by using the information on the ADC when the kite flying line is 25 m (page 46) or 100 feet (page 48).
6. For other flying lines, see Student pages 45 and 47 for determining altitudes.
7. For using "standard" measurements, use student pages 47 and 48.

Part III - The Beaufort Scale

Some kites fly in almost a dead calm; others survive a gale. Most flying is done, however, with winds in the range from 4 to 18 miles per hour--and the steadier the better. It is useful, though not necessary, to know how fast the wind is moving.

In 1805, Rear Admiral Sir Francis Beaufort devised his classic wind scale for sailors, rating 0 as a dead calm and 12, the top number, as a hurricane. The numbers from 1 to 6, which are germane to kite flying, can be translated like this:

1. 1 to 3 mph. Smoke drifts lazily
2. 4 to 7 mph. Tree leaves rustle
3. 8 to 12 mph. Small flags fly, leaves dance
4. 13 to 18 mph. Trees toss, dust flies, paper kitters
5. 19 to 24 mph. Trees sway, kite strings break
6. 25 to 31 mph. Flying's risky

You can buy simple, dependable wind meters for a few dollars (the DWYER is one). They eliminate guesswork quite as well as elaborate outfits that cost much more and require fixed installation. The kite-flier's question is really very simple: "Is there enough wind to fly my kite?" Take your kite out and hold it up by the bridle, facing the wind. If it assumes a flying posture, you're in business.

The bound wind and upper wind often differ in velocity, steadiness, and even in direction. But, if you can coax your kite up through the tricky ground wind, there comes that magic moment when the true wind takes hold, and your kite soars. If you are in the open, the wind's directional variation, usually not more than a few degrees, offers not problem.

Part IV - Kite Flying Safety Rules

1. Do not fly in the rain.
2. Observe all rules established by local authorities (police, fire, recreation departments, etc.).
3. Do not fly across roads.
4. Do not fly near or across power lines.
5. Do not attempt to retrieve kites lodged in trees, roofs, or power lines.
6. Do not fly in crowded areas (beaches, parks, etc.).
7. Do not fly too close to airports.
8. Do not fly kites that have metal in their constructions or tails.
9. Respect private property at all times.

VII. **Management Suggestions**

1. Estimated construction times:
   a. Paper kite (Student page 40) - 30 minutes
   b. Dutch kite (Student pages 41-42) - 45 to 60 minutes
   c. Straw kite (Student page 43) - 45 to 60 minutes
2. The classroom teacher is the overall person in charge for the entire activity.
3. Students may be divided into small groups (4, 5, or 6 per group).
4. Each group will share the construction, flying and recording of information (Student page 44).
5. A flight manual has been provided so students can record their experiences in constructing and flying one of the kites (Student pages 49 and 50).

VIII. **Procedure**

For kite construction, use these 3 kites for this investigation: Kite activities 20, 21 and 22 (Student pages 40-43).

IX. **What the Students Will Do**

1. The students will construct the kites.
2. The students will record:
   a. Date of flight
   b. Wind speed (Dwyer wind meter, call local airport, or refer to Beaufort scale, see Student page 49)
3. The students will fly their kites.
4. The students will measure altitude of kite, using different length of line.
5. Students will record and graph the altitude information.
6. Students will find averages (height) for 3 or more flights.

X. **Discussion**

1. Will your kite fly higher if you use more (longer) string?
2. What is the highest altitude your kite will fly using any length of string?
3. How much higher will your kite fly in a stronger breeze?
4. How much wind (at least) do you need to fly your kite?
5. Can you fly your kite directly overhead? Why? Why not?
6. Will a larger kite fly higher than a smaller kite - in the same breeze? Why? Why not?
7. Is there a constant ratio between the altitude and the length of the string used?

XI. **Extension**

1. Make a class graph showing the altitudes of all kites flown with the same length of string. Find the average altitude.
2. Compare the altitudes of kites of the same size that have been constructed from different materials (ditto paper, tagboard, posterboard, etc.).
3. Select the length of lines to be used. Have a contest. Which kite flies highest? Which remains aloft longest?
4. Construct kites of different sizes (scale-up or scaled-down versions of the original kites).
5. Determine the surface area of your kite.

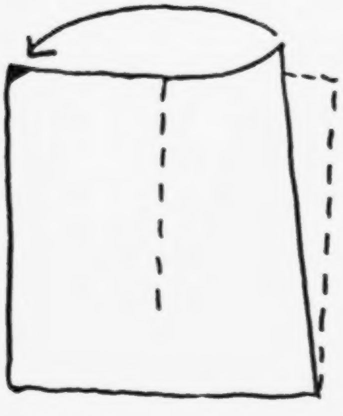
A Paperfold Kite

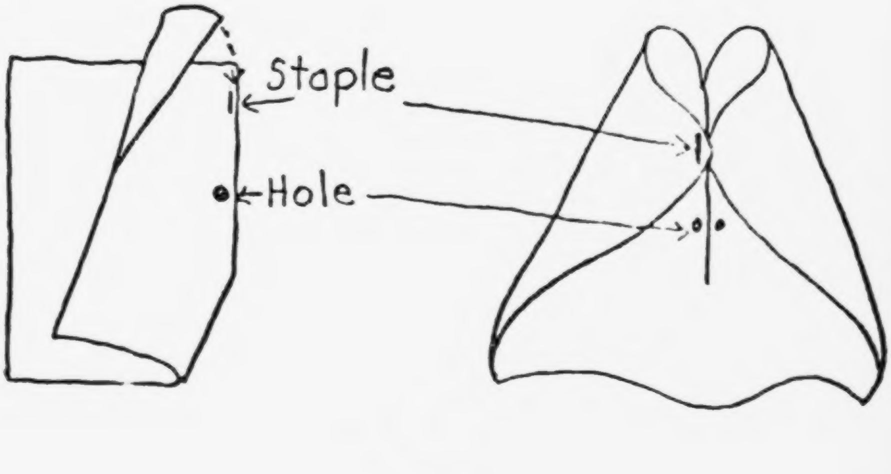
All students should know about a folded paper kite. There is nothing like it for lifting the spirit. You can design, produce, and have a paper kite airborne in a couple of minutes. All you need is a sheet of paper (typewriter bond is fine), a small stapler, scissors, and a spool of sewing thread.

One of the best designs has the triangular shape of the paper darts or gliders every schoolboy makes. It has no sticks, fins, rudders, tails, stabilizers, or other structural additions. Nor is the design violently precise, for the kite can be made from either a square or oblong piece of paper, from about 8 by 8 inches on up. The proportion of width to length should not exceed 4 to 3, but square is optimum.

The kite requires one center fold. If your paper is rectangular, begin folding so that the short sides meet, but take care to crease the paper for bend down (don't crease) the front two corners of the sheet so that they meet outside the fold, at the keel, about an inch back from the nose. Line them up neatly and staple them to and through the keel.

Next, mark a spot on the keel about a half inch forward of the midpoint. Punch a hole there with a hole-punch. Tie the thread to the kite at this point. You are now ready to fly your kite.





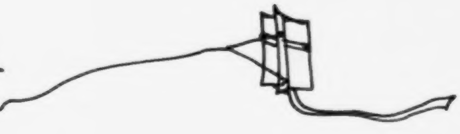
DUTCH KITE

The Dutch Kite incorporates the basic elements needed for flight--a spine, a crosspiece, a bridle to hold the kite face to the wind, and a tail for stability. It flies easily in light breezes or heavy winds. It is a tolerant kite and even though a less than perfect model, will still fly.

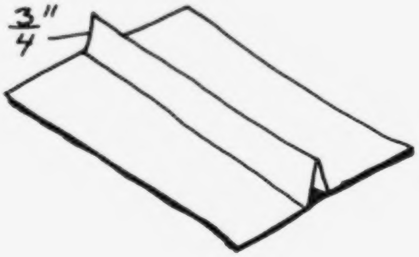
Materials Needed:

- Stiff paper (8½ x 11) ditto or typing paper is great)
- Elmer's glue
- Paper hole punch
- Crepe paper for tail (a strip 1" wide by 4' long is adequate)
- Spool of sewing thread

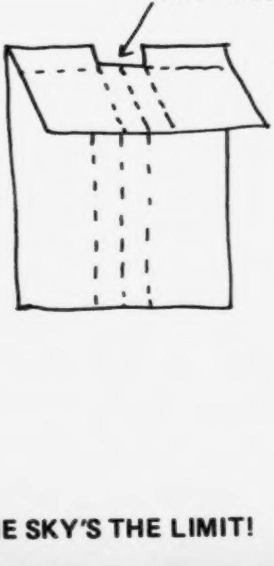
MAKING THE KITE

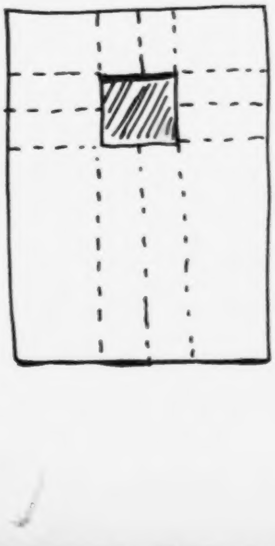


1. Fold and crease the paper longway. Fold and crease again, 3/4" from center fold. Open so the folded section forms a ridge up the middle. This will be the front of the kite.



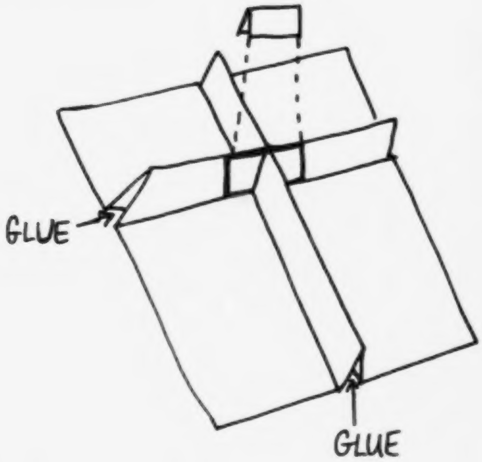
2. Open paper flat. Fold and crease on a line 3" from the top (short way). Fold and crease 3/4" from this fold. Unfold this crease and cut on the heavily marked lines at the top. Open paper flat, back side up.



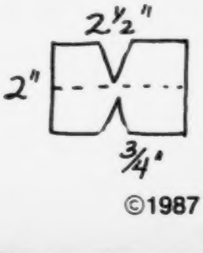


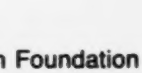
3. Put glue on the top and bottom sections of the long middle fold (between the fold lines), but not on the cross-folded section where the cut-out part is. Fold in center, spreading sides out flat, thus gluing the spine of the kite. Now glue the 2 cross sections at top.

4. Glue the square piece of paper you cut out (in step 2) so that it joins together the 2 top cross sections.

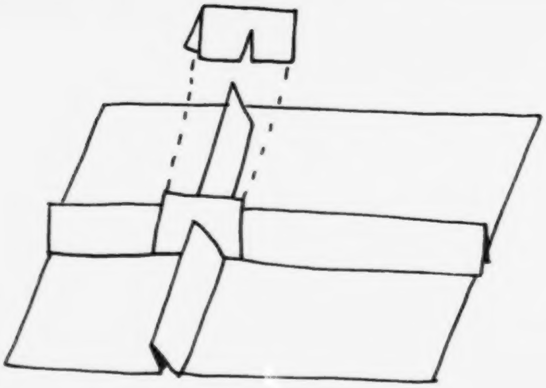


5. Take a scrap piece of paper (2" x 2½") and fold in the middle, across the 2" dimension.

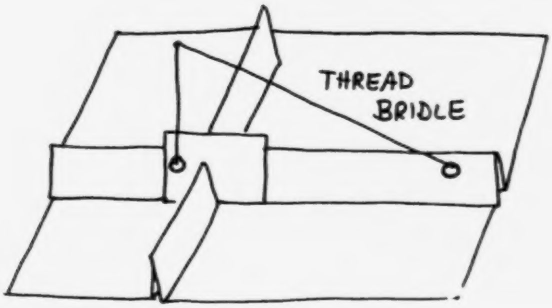




Cut a slit 3/4" high through the center of the paper. Glue this to the long center spine to connect the spines together.

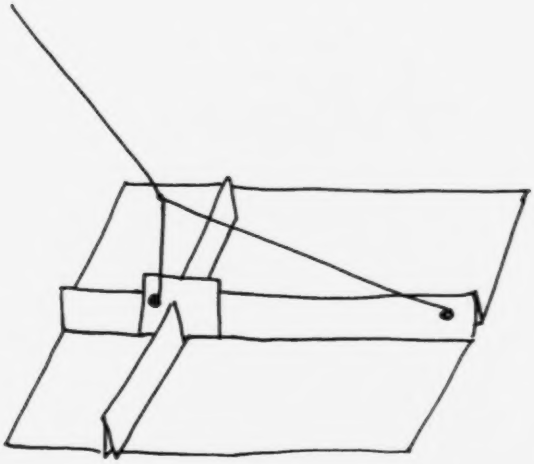


6. Punch two holes for the Bridle.



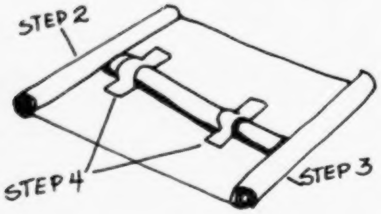
Attach kite flying string

7. Glue the 1" x 4' tail of crepe paper to the back of the kite.



YOUR KITE IS READY TO FLY!

3-STRAW KITE



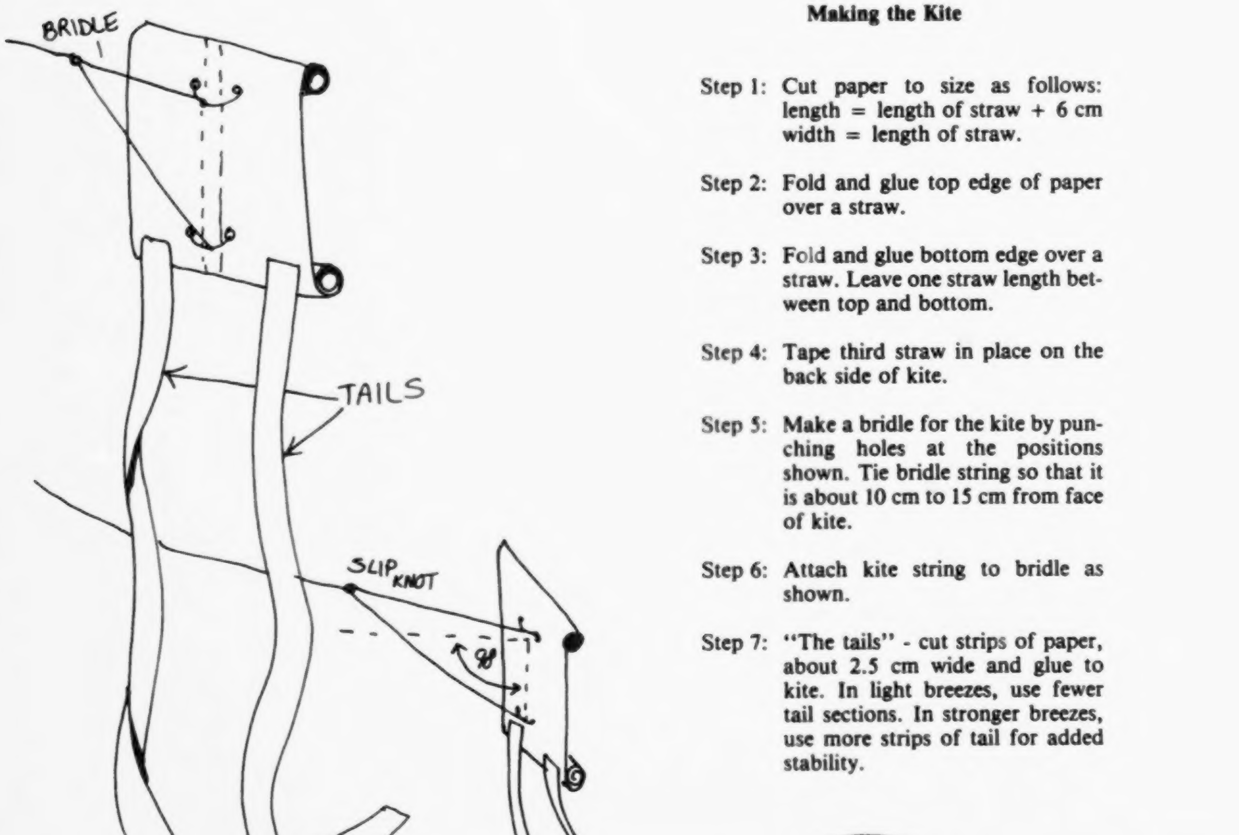
3-Straw Kite

Often we forget that kites need not be complex or expensive. Here is a kite design that is both simple and efficient. Best of all, the cost is quite low!

Materials Needed:

- 2 sheets of paper
- 3 plastic straws
- White glue or rubber cement
- Tape
- Kite string or thread

—MAKING THE KITE—



Making the Kite

Step 1: Cut paper to size as follows:
length = length of straw + 6 cm
width = length of straw.

Step 2: Fold and glue top edge of paper over a straw.

Step 3: Fold and glue bottom edge over a straw. Leave one straw length between top and bottom.

Step 4: Tape third straw in place on the back side of kite.

Step 5: Make a bridle for the kite by punching holes at the positions shown. Tie bridle string so that it is about 10 cm to 15 cm from face of kite.

Step 6: Attach kite string to bridle as shown.

Step 7: "The tails" - cut strips of paper, about 2.5 cm wide and glue to kite. In light breezes, use fewer tail sections. In stronger breezes, use more strips of tail for added stability.

Form Number 202122 AK
Section Number 11PAK

(Have students select one of the kite models they have made for use in this section. Encourage them to choose different versions.)

Official Use Only	AW	WP
	LE	ZZ

FLIGHT DATA SHEET

Project Manager ______
Sponsoring Firm ______
Address ______
______
Testing and Evaluation Form 192021 A

PREFLIGHT INFORMATION

Kite Name ______
Kite Number ______
Type of Kite ______
Date Completed ______

MODEL SPECIFICATIONS

(Encourage students to measure precisely, using metric units, eg. 25.6 cm)

Length ______
Width ______
Shape ______
Area ______
Weight ______
Signature

Materials ______
______
Bonding Agent ______
Attachment of Flying String ______
Tail Yes ______ No ______ Specify ______
Design Engineer

CONSTRUCTION PROCESS

Please describe below the construction process, making particular mention of difficulties encountered or special manufacturing techniques.

(As a language arts activity, have students write a paragraph detailing their experiences in building the chosen kite model.)

Signature
Construction Engineer

COLOR SCHEME ______
DISTINGUISHING MARKS, IF ANY ______

BEAUFORT NUMBER AND LAND WIND EFFECT

(For use with section 22W)

m.p.h.	Beaufort Number	Land–wind effect	Designation of wind
0–1	0	Calm; smoke rises vertically	Light
1–3	1	Wind direction just shown by smoke	Light
4–7	2	Wind felt on face; leaves rustle	Light
8–12	3	Leaves and small twigs in motion	Gentle
13–18	4	Dust rises; small branches move	Moderate
19–24	5	Small trees in leaf begin to sway	Fresh
25–31	6	Large branches move	Strong

Form Number 202122 AK Section Number 22R

OFFICIAL USE ONLY X Z PQ W

PREFLIGHT CHECKLIST

(In order to comply with insurance regulations, this section must be completed and initialed by the flight engineer prior to flight.)

☐ 1.
☐ 2.
☐ 3.
☐ 4. (As a reinforcement to follow class
☐ 5. discussion, have students write in the
☐ 6. safety rules for flying kites here. then,
☐ 7. check them off on site when actually
☐ 8. flying.)
☐ 9.
☐ 10.

Initialed Flight Engineer

Section Number 22W

WEATHER CONDITIONS

	Flight No. 1	Flight No. 2	Flight No. 3	Flight No. 4
Wind Direction				
*Wind Velocity/Beaufort No.				
*Wind Velocity/Range or Actual				
Humidity				
Temperature				
Visibility				
Remarks				
Date and Verification †				

*USE TABLE PAGE 1. Look for appropriate description of effect; find Beaufort Number; record range (eg. No. 5 indicates 19–24 mph.) or call the Weather Bureau. † Initial–Flight Engineer

Add Written Evaluation On Reverse Side

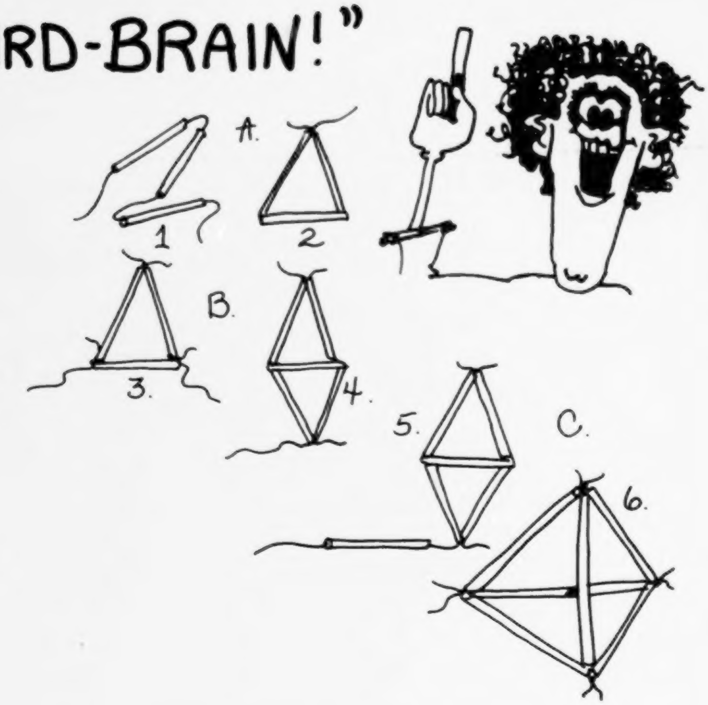
FLIGHT DATA

Section 22FDAK

		Flight No. 1, / /	Flight No. 2, / /	Flight No. 3, / /	Flight No. 4, / /
ALTITUDE	Estimated Altitude				
	Angle				
	Computed Altitude				
FLIGHT DURATION					
STABILITY INFORMATION					
FLIGHT PERFORMANCE					

(You may decide to select a specific day for completing this section or have students use previously collected information.)

BERNOULLI WAS A "BIRD-BRAIN!"



I. Topic Area

Making a tetrahedron kite

II. Introductory Statement

After building and flying a tetrahedron kite, the students should be able to explain how the kite flies in terms of Bernoulli's Principle and demonstrate the mathematical importance of the tetrahedron.

III. Math Skills	**Science Processes**
a. Geometry, plane and solid	a. Predicting
b. Finding surface area, volume	b. Observing and describing
c. Finding ratios	

IV. Materials

Per basic kite:
- 24 plastic straws
- Kite string
- 1 full sheet of tissue paper
- Rubber cement (this really works best)
- Scissors
- Student pages 51, 52, 53 for instructions and pattern
- Student page 54 for worksheet

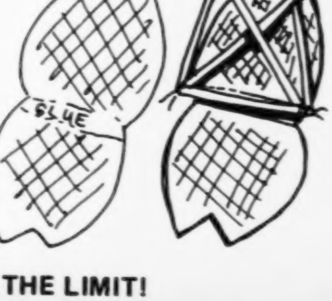
V. Key Question

"What did Bernoulli learn from the flight of birds? What happens if we build a kite that is based on these principles?"

VI. Background Information

We live at the bottom of an ocean--an ocean of air. This air presses on everything. We call this "air pressure." Bernoulli discovered that air doesn't press as hard when it is moving. The faster it moves, in fact, the less it presses. Because an airplane wing is curved along the top and flat on the bottom, the air has to go faster over the top, decreasing the air pressure. Since this moving air does not press down as hard as the air around it, "lift" is created, helping the wind, and the plane, to stay up.

Now, Bernoulli had to discover this principle of aerodynamics himself. Birds have always had it built in!! They are natural models of Bernoulli's principle. Furthermore, the bird's wings are used to "channel" the air moving over its curved body, making it move that much faster because it has less room in which to move. The kite we are going to make imitates this design of nature.



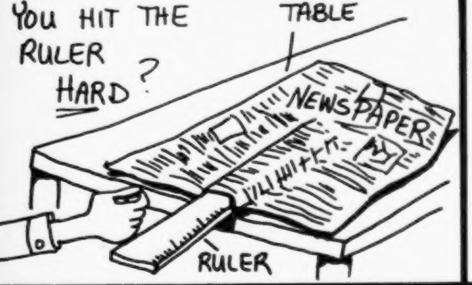
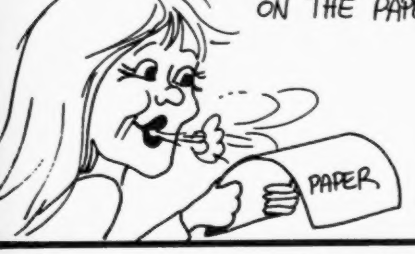
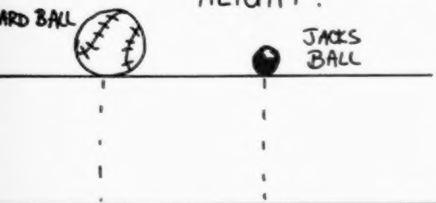
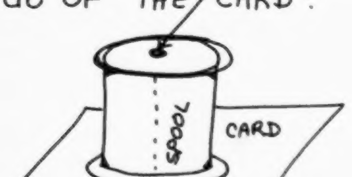
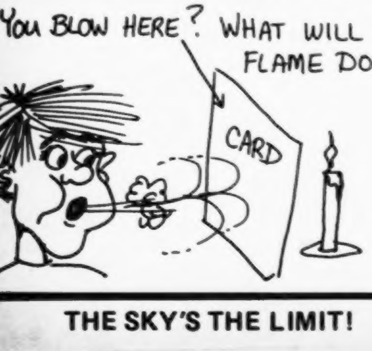
The kite is build of tetrahedra--solid geometric figures constructed of four equilateral triangles. Since four of them are put together to make the basic kite, it is itself shaped like a tetrahedron. There are several advantages to this design: first, the tetrahedron is one of the most stable of all solid shapes; second, by covering only 2 sides of each tetrahedron, we can channel the air just as a bird does with its wings. In flying their kites, your students may be able to suggest other advantages.

VII. Management Suggestions

1. Divide the class into pairs as it will make everything easier.
2. You may or may not want each student to have a copy of the directions, but, in any case, show and tell as they construct the first tetrahedron.
3. Plan to build the kites in two stages. On the first day, construct the four tetrahedra. On the second day, cut the gores, cover the tetrahedra, and assemble. For some classes, this may require an hour each session. If using white tissue paper, consider allowing extra time for decorating the gores before covering the gores.
4. Consider teaching a few students how to do it before working with the whole class, so they can assist.
5. Helpful hints for constructing:
   a. Pre-cut the strings.
   b. Use square knots. Joints can be taped with scotch tape for added strength.
   c. You can use extra, smaller straws inside to prevent bending, but the added weight may be detrimental.
   d. Repairs to bent straws can be made by slitting an extra straw, slipping it over, and taping.
   e. Use rubber cement for covering - application is easy; color won't run.
6. Have students provide their own string for flying. Have students or cafeteria provide straws. The gore pattern may have to be adjusted for smaller straws.
7. These are beautiful when hanging - for Open House? Also, you may have to wait for windy day. Hang a clothes line and tie them on by the "head strings."

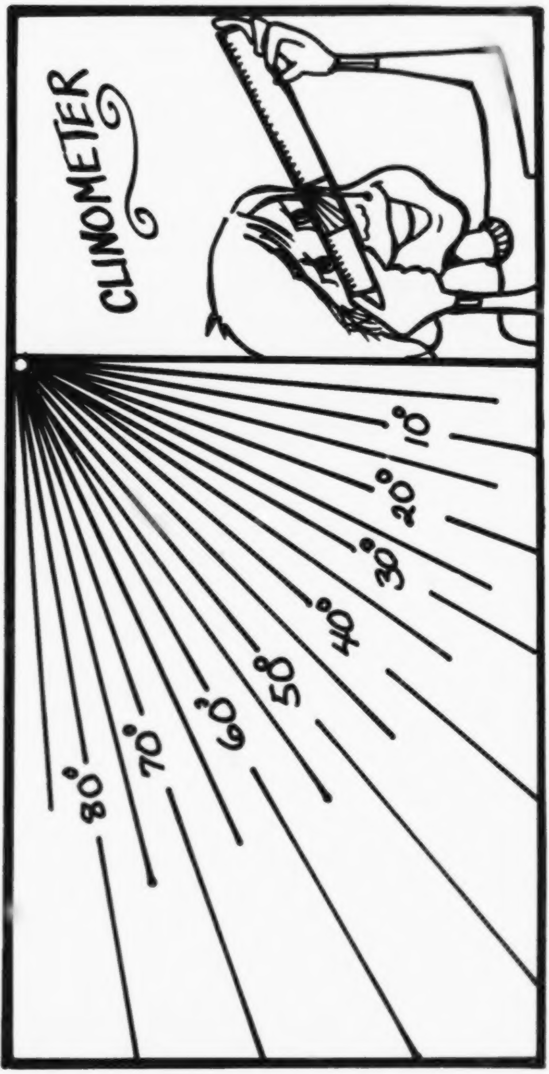
____________________NAME

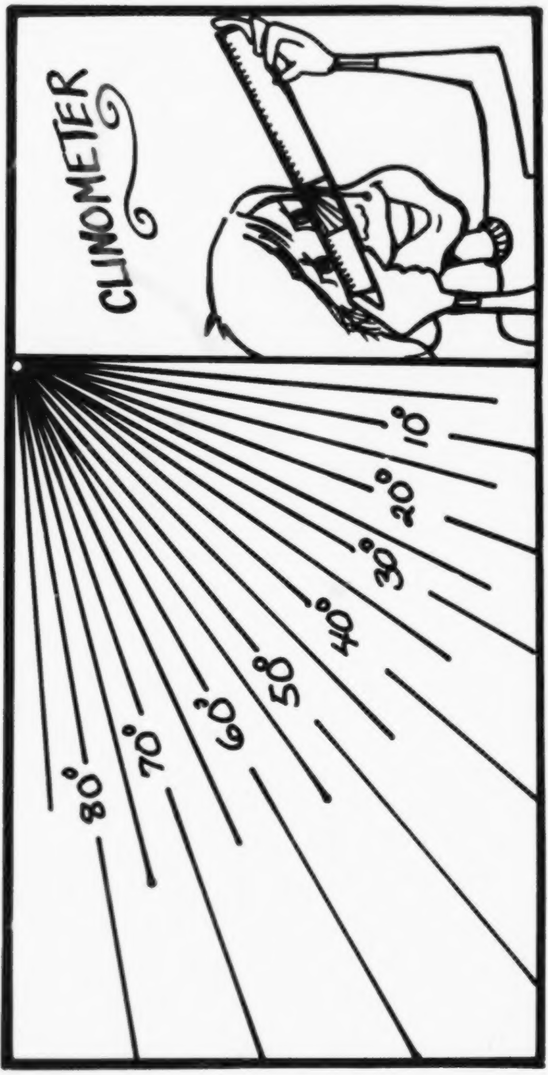
SEEING IS BELIEVING!

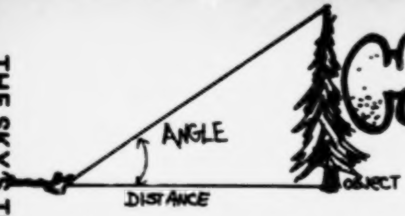
WHAT WILL HAPPEN IF	YOUR PREDICTION	YOUR OBSERVATION
YOU HIT THE RULER HARD?  TABLE NEWSPAPER RULER		
YOU BLOW ON THE PAPER?  		
YOU DROP BOTH AT THE SAME TIME FROM THE SAME HEIGHT?  ARD BALL JACKS BALL		
YOU BLOW IN HERE AND LET GO OF THE CARD?  SPOOL CARD PIN		
YOU BLOW HERE? WHAT WILL THE FLAME DO?  		

CONSTRUCTING YOUR CLINOMETER

1. You will need a copy of the clinometer pattern, a 20 cm piece of thread, a washer, a ruler and scotch tape to construct your clinometer.
2. With a pair of scissors, cut down to the white dot on the clinometer (the vertex of the angles).
3. Lay one end of the thread into the cut so that 2 cm of thread hangs on the backside of the clinometer.
4. Tape that end of the thread securely to the back.
5. Tie a washer to the other end and make sure the thread swings freely from the vertex.
6. To provide a sighting plane, tape the clinometer to a ruler or a large straw.







HOW HIGH IS IT?

______________ NAME

NAME OF OBJECT	ESTIMATE OF OBJECT'S HEIGHT	ANGLE	TANGENT OF ANGLE	× DISTANCE FROM OBJECT	= HEIGHT OF OBJECT
1.				m	m
2.				m	m
3.				m	m
4.				m	m
5.				m	m
6.				m	m
7.				m	m
8.				m	m
9.				m	m
10.				m	m
11.				m	m
12.				m	m
13.				m	m
14.				m	m
15.				m	m
16				m	m

NAME ____________

HOW HIGH CAN YOU THROW?

	UP & DOWN TIME	DOWN TIME (÷2)	DOWN DOWN TIME x TIME	X 490cm	÷ 100 = DISTANCE
FIRST THROW				cm	m
SECOND THROW				cm	m
THIRD THROW				cm	m
TOTAL				TOTAL	m
÷ 3 = AVERAGE				÷ 3 = AVERAGE	m

AVERAGE TIME = ________ SECONDS

AVERAGE DISTANCE = ________ meters

BEST ☆ DISTANCE ________ meters

NAME ______________________

UNBELIEVABLE FLYING OBJECTS

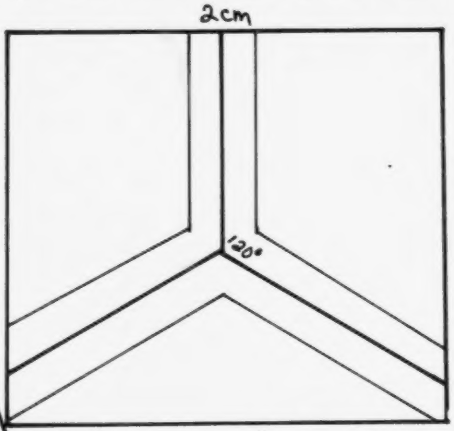


figure 3

6" square paper
Use A Ruler And
A Protractor

Use a 7cm radius to
draw your circle. Keep
the compass at 7cm
and mark off
6 equal arcs.

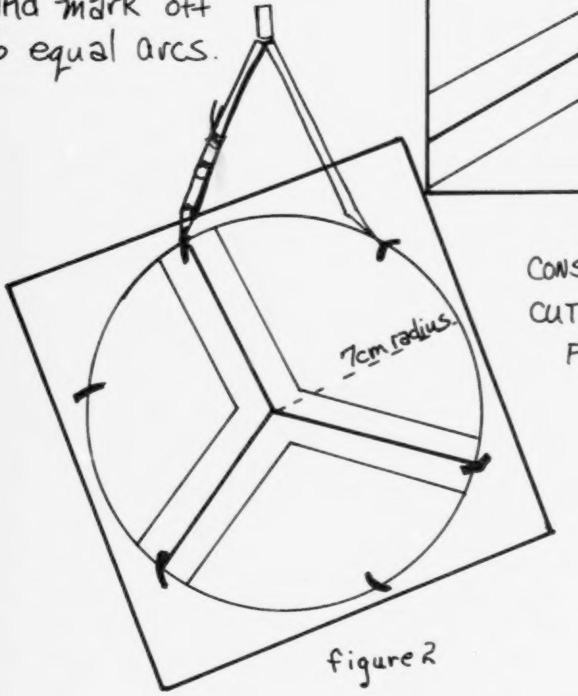


figure 2

CONSTRUCT
CUT OUT &
FLY!

6 inch square
Use a ruler.

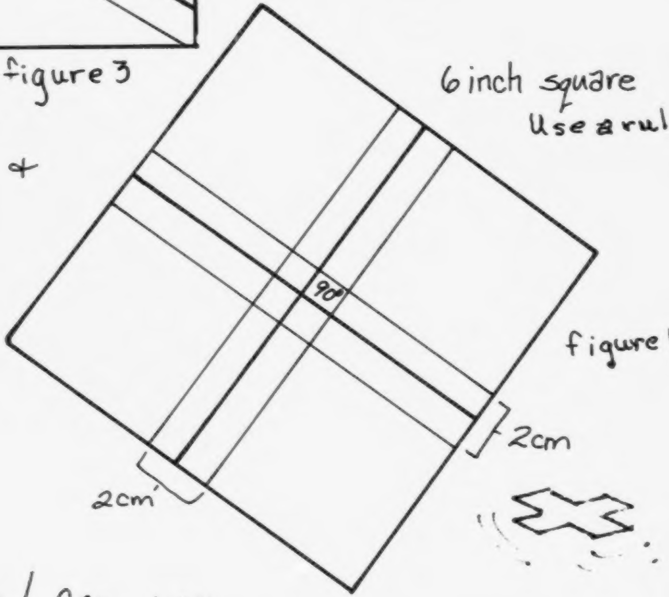
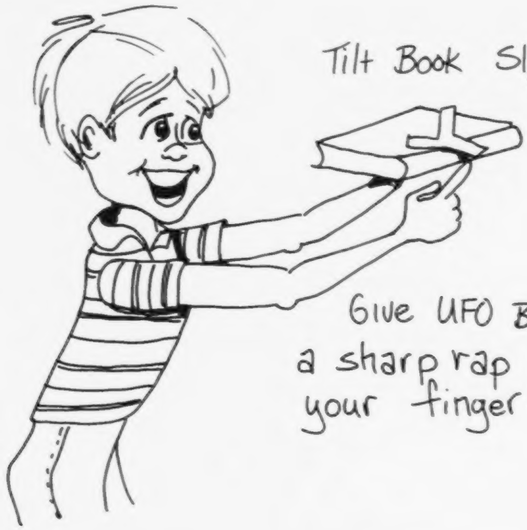


figure 1

Now Try a 6 pointed UFO! Can you make one with 5 sides! Construct your own UFO of a different size and shape.



Tilt Book Slightly

Give UFO Blade
a sharp rap with
your finger!

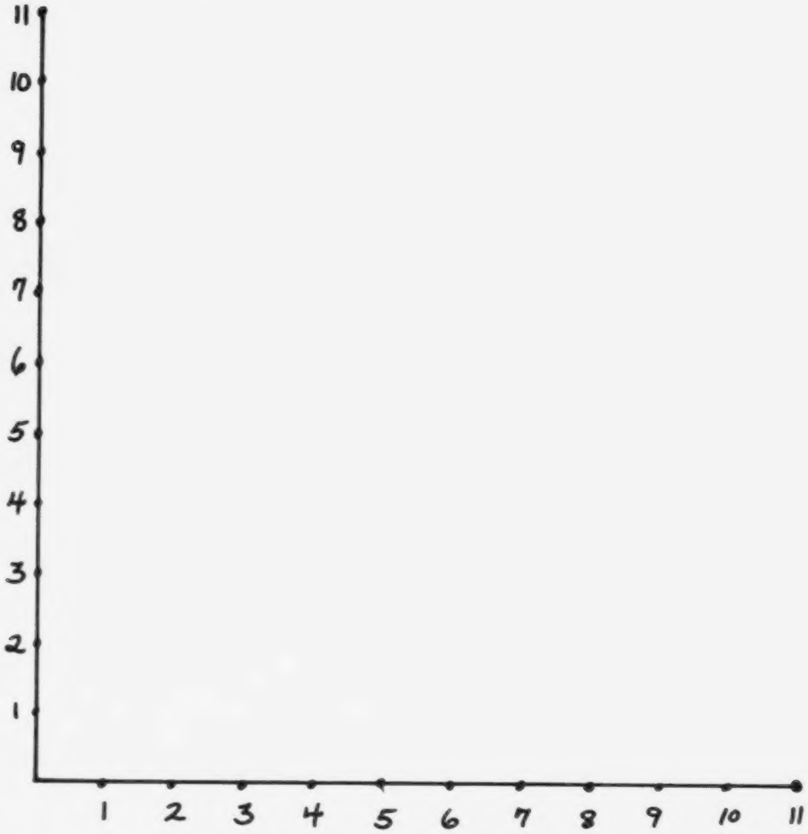
Sketch all the UFOs that
will boomerang!

NAME

Line Drawings

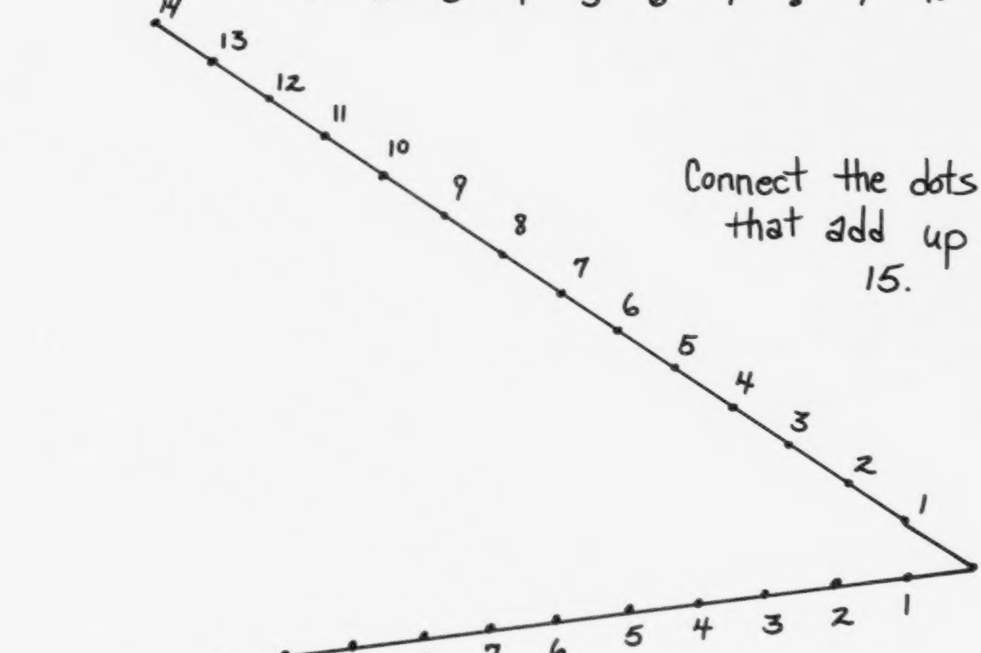
MORE UFO's

Connect the dots that add up to 12.



1
2
3
4
5
6
7
8
9
10
11
1
2
3
4
5
6
7
8
9
10
11

Connect the dots that add up to 15.



14
13
12
11
10
9
8
7
6
5
4
3
2
1
1
2
3
4
5
6
7
8
9
10
11
12
13
14

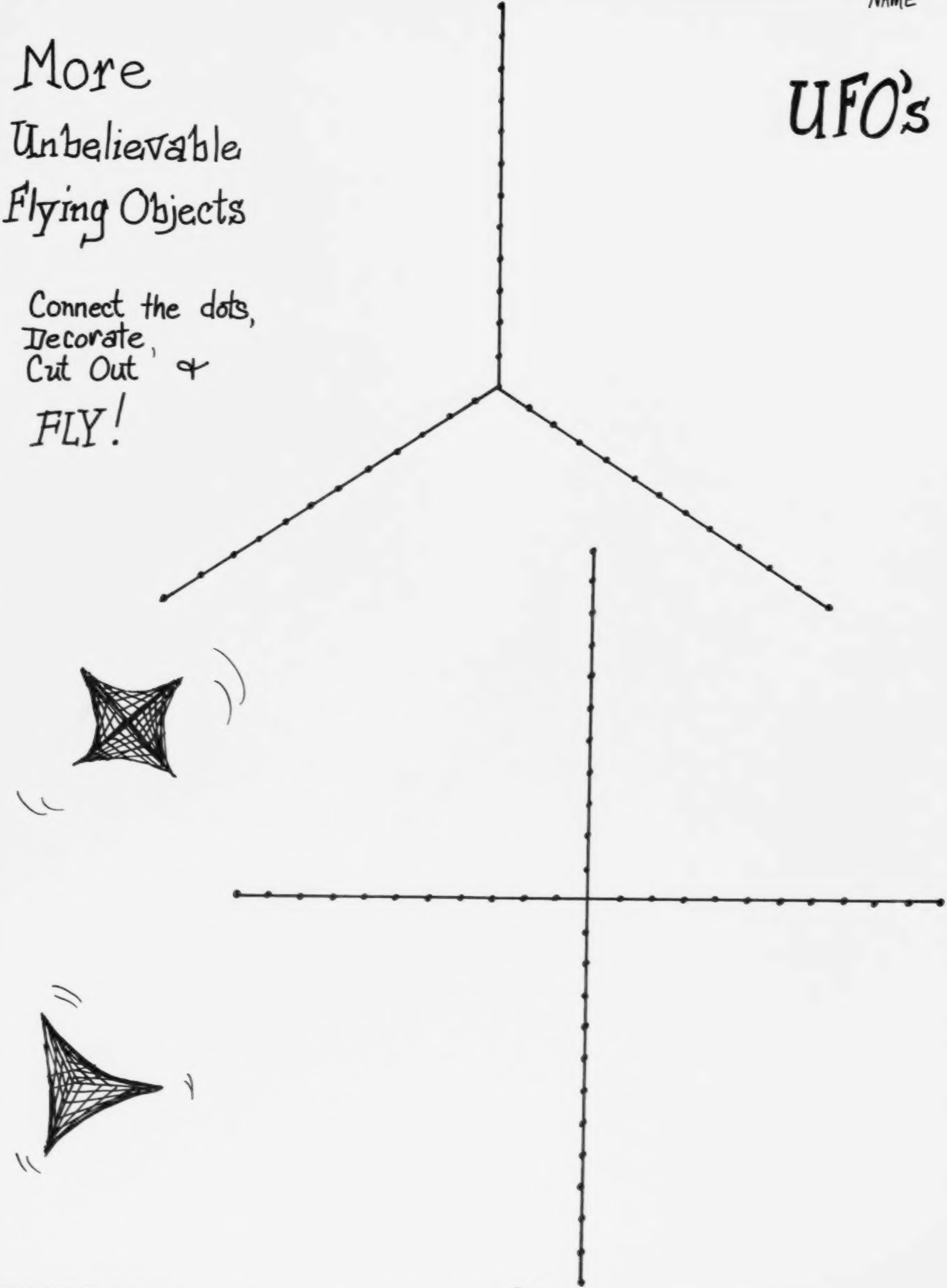
_______________ NAME

More Unbelievable Flying Objects

UFO's

Connect the dots,
Decorate,
Cut Out &

FLY!



__________________________ NAME

.....But Will It FLY?

FLYING POLYGONS - SHEET #1

1. WHAT IS THE SMALLEST NUMBER OF STICKS YOU CAN USE TO BUILD A POLYGON WHICH YOU CAN PICK UP? __________

SKETCH YOUR POLYGON -

A. HOW MANY SIDES DOES IT HAVE? _______ HOW MANY ANGLES? _______

B. WHAT IS IT CALLED? ____________________

2. WHAT IS THE GREATEST NUMBER OF STICKS YOU CAN USE TO CONSTRUCT A POLYGON YOU CAN PICK UP? _________

SKETCH YOUR POLYGON -

A. HOW MANY SIDES DOES IT HAVE? _______ HOW MANY ANGLES? _______

B. DOES IT HAVE A NAME? _______________________

3. SKETCH ANY OF THESE POLYGONS WHICH YOU CAN CONSTRUCT.

A. 3 SIDES B. 4 SIDES C. 5 SIDES D. 6 SIDES

FLYING POLYGONS - STUDENT SHEET 2

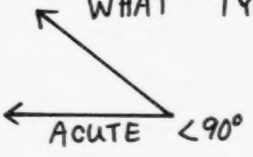
______________________ NAME

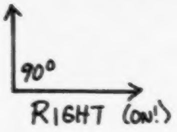
....But Will It FLY?

A. POLYGON PARTICULARS

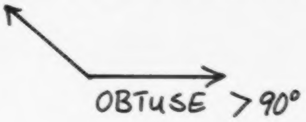
HOW MANY BRACES DID YOU NEED?

WHAT TYPE OF ANGLES ARE IN YOUR POLYGONS?


ACUTE <90°



RIGHT (ON!)


OBTUSE >90°

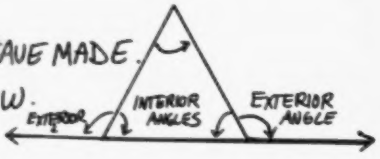
# OF SIDES	# OF BRACES	# OF ANGLES	TYPE OF ANGLES	NAME OF POLYGON
3				
4				
5				
6				
7				
8				

B. ULTIMATE ANGLES - FOR THE BRAVE AND CLEVER!

DRAW, OR TRACE, AROUND THE OUTSIDES OF THE POLYGONS YOU HAVE MADE.

1) MEASURE THE INTERIOR ANGLES. FILL IN THE TABLE BELOW.

2) MEASURE THE EXTERIOR ANGLES. ADD THE INFORMATION TO YOUR TABLE.



# OF SIDES	# OF ANGLES	MEASUREMENT - INTERIOR ∠'S	MEASUREMENT - EXTERIOR ∠'S
3			
4			
5			
6			
7			
8			

DO YOU THINK THERE IS A PATTERN?

CAN YOU WRITE A FORMULA FOR FINDING THE MEASUREMENT OF AN EXTERIOR ANGLE?

CAN YOU WRITE A FORMULA FOR FINDING THE MEASUREMENT OF AN INTERIOR ANGLE?

____________________ NAME

....But Will It "FLY"?

FLYING POLYGONS - STUDENT SHEET 3

NOW THAT YOU HAVE CONSTRUCTED THE POLYGONS, SEE IF THEY WILL FLY!

WORK WITH YOUR PARTNER SO THAT YOU HAVE 2 OF EACH TYPE TO TEST.

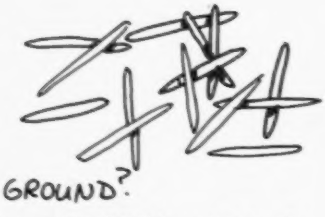
A. HOW FAR CAN YOU FIY EACH OF YOUR POLYGONS?

1. MEASURE THE DISTANCE FROM THE LAUNCH LINE TO THE POINT AT WHICH EACH HIT THE GROUND.
2. RECORD THE RESULTS HERE. HAVE A CLASS CHART.

TYPE OF POLYGON	DISTANCE	TYPE OF POLYGON	DISTANCE
TRIANGLE A		HEXAGON A	
TRIANGLE B		HEXAGON B	
SQUARE A			
SQUARE B			
PENTAGON A			
PENTAGON B			

WERE THE RESULTS CONSISTENT AMONG GROUPS?

DO CERTAIN POLYGONS SEEM MORE STABLE?



B. AND WHEN THE WHOLE SYSTEM FALLS APART . . . .

(WHICH IT PROBABLY WILL)

HOW FAR APART DID THE STICKS LAND WHEN THEY HIT THE GROUND?

1. WHEN EACH POLYGON HITS THE GROUND AND FALLS APART, CIRCLE THE AREA WITH A LENGTH OF STRING WHICH ENCLOSES ALL THE STICKS.
2. MEASURE THE LENGTH OF THE STRING NEEDED (CIRCUMFERENCE OF THE CIRCLE, $C = 2\pi r$) FIND THE AREA OF THE CIRCLE ($A = \pi r^2$) $\pi = 3.14$ or $\frac{22}{7}$
3. MAKE A CHART FINDING YOUR DATA. DOES THE AREA OF THE CIRCLE COVERED INCREASG AS THE NUMBER OF STICKS INCREASE?
4. DOES THE AREA OF THE CIRCLE INCREASE CONSISTENTLY AS THE DISTANCE FLOWN INCREASES?

OR, PLAY "PICK UP STICKS"

BE A ROTOR PROMOTER

ADOPT A
COPTER TODAY!

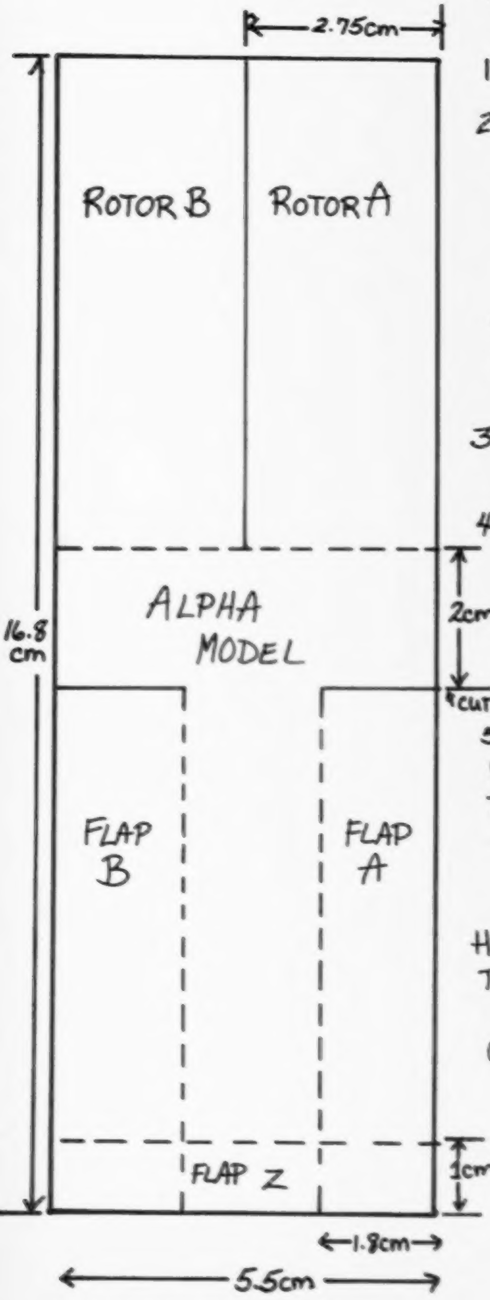
HERE ARE TWO PATTERNS FOR A PAPER ROTOR OR TWISTER - A HELICOPTER. CHOOSE A PARTNER: IF ONE OF YOU CONSTRUCTS THE ALPHA AND ONE THE BETA, YOU CAN COMPARE THE PERFORMANCES.

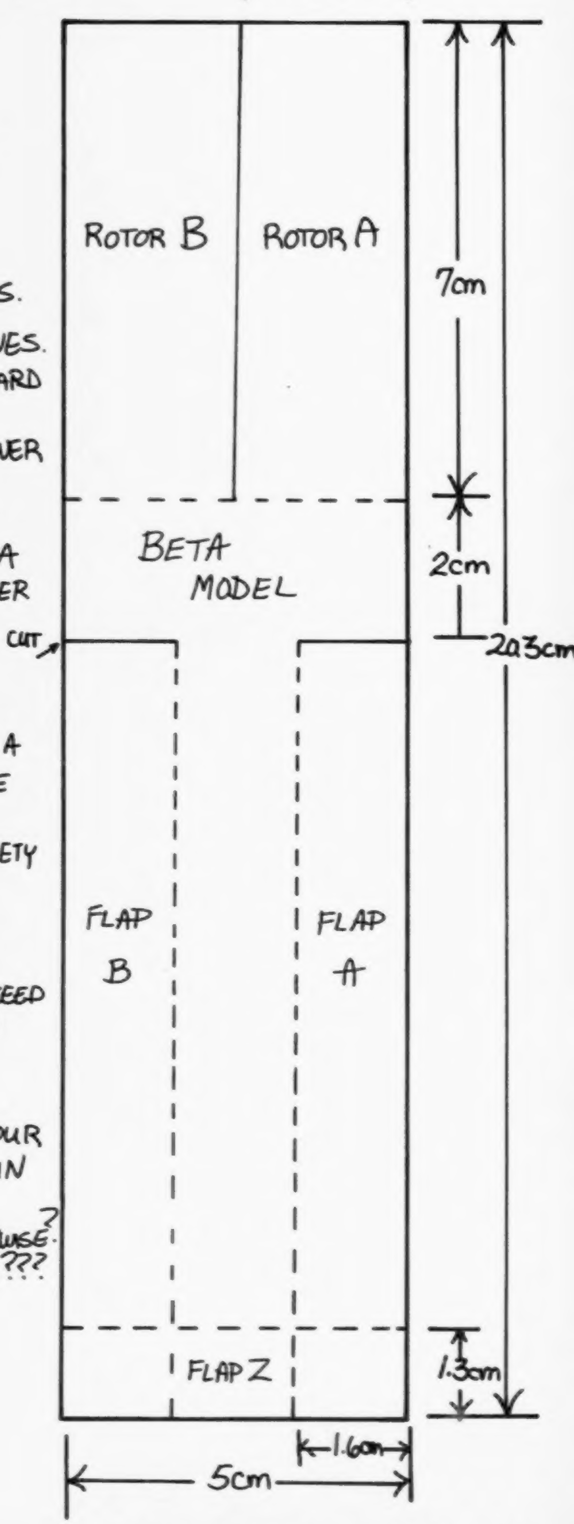
TRY YOUR MODELS MADE OUT OF FILING CARDS (5X8) INSTEAD OF PAPER. TRY OTHER MATERIALS.

TO BUILD:

1. CUT ALONG THE SOLID LINES.
2. FOLD ALONG THE DASHED LINES. FIRST, FOLD FLAP A IN TOWARD THE CENTER.
   THEN, FOLD FLAP B IN OVER FLAP A.
   NEXT, FOLD FLAP Z UP TOWARD YOU UNTIL IT MAKES A RIGHT ANGLE WITH THE OTHER FLAPS.
3. NOW, FOLD ROTOR A BACK AND ROTOR B FORWARD
4. DROP YOUR HELICOPTER IN A TEST FLIGHT TO DETERMINE WHETHER IT ROTATES.
   EXPERIMENT WITH A VARIETY OF ADJUSTMENTS.
5. WHEN YOU ARE SATISFIED WITH YOUR TEST FLIGHT, PROCEED TO THE RECORD/COMPETITION SHEET.

INCIDENTALLY, DOES YOUR HELICOPTER ALWAYS SPIN IN THE SAME DIRECTION? CLOCKWISE OR COUNTERCLOCKWISE? CAN YOU MAKE IT REVERSE???


2.75cm
ROTOR B
ROTOR A
ALPHA MODEL
16.8 cm
2cm
CUT
FLAP B
FLAP A
FLAP Z
1cm
1.8cm
5.5cm


2.5cm
ROTOR B
ROTOR A
7cm
BETA MODEL
2cm
CUT
20.3cm
FLAP B
FLAP A
FLAP Z
1.3cm
1.6cm
5cm

__________________________NAME

BE A ROTOR PROMOTER

ADOPT A COPTER TODAY!

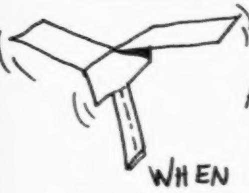
RECORD/COMPETITION SHEET

MY HELICOPTER IS ________________ MODEL

DISTANCE OF DROP__________cm

DESCENT TIME

NAME ________________	TIME	NAME ________________	TIME
TRIAL #1		TRIAL #1	
TRIAL #2		TRIAL #2	
TRIAL #3		TRIAL #3	
TRIAL #4		TRIAL #4	
TRIAL #5		TRIAL #5	
TRIAL #6		TRIAL #6	
TOTAL		TOTAL	
AVERAGE		AVERAGE	



WHEN YOU HAVE FOUND THE TIME IN SECONDS, YOU CAN DETERMINE THE RATE AT WHICH YOUR HELICOPTER FALLS BY USING A FORMULA:

$S = r \cdot t$

S = DISTANCE (HEIGHT FROM WHICH YOU DROPPED YOUR TWISTER)

t = TIME IT TOOK TO HIT GROUND

YOU ARE TRYING TO FIND Rr.

WHAT CAN YOU DO IF YOU KNOW S AND t ?

TRIAL #1 r =

TRIAL #2 r =

TRIAL #3 r =

TRIAL #4 r =

TRIAL #5 r =

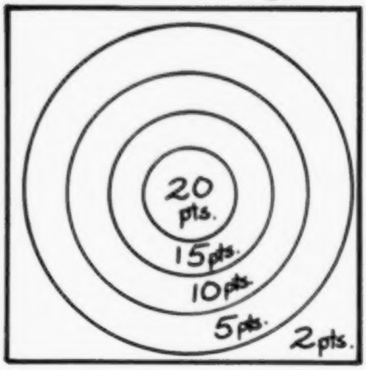
TRIAL #6 r =

MAKE A DOUBLE BAR GRAPH COMPARING THE RATES OF YOUR COPTER WITH YOUR PARTNERS.

______________________ NAME

BE A ROTOR PROMOTER

ADOPT A COPTER TODAY!



NOW THAT YOU HAVE FIGURED OUT THE RATE AT WHICH YOUR COPTER CAN FALL, SEE HOW ACCURATELY IT WILL LAND!

MAKE A POSTER BOARD TARGET AND PUT IT ON THE FLOOR. IN TURN, YOU AND YOUR PARTNER WILL DROP YOUR COPTERS FROM A GIVEN HEIGHT.

KEEP SCORE!

WHICH COPTER WAS MOST ACCURATE?

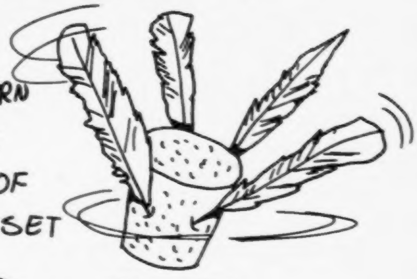
NAME	
TURN	SCORE
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

NAME	
TURN	SCORE
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

______________________ NAME

IT'S A REAL CORKER!

IN THIS INVESTIGATION, YOU ARE GOING TO MAKE ANOTHER TYPE OF HELICOPTER, USING A CORK AND FEATHERS (OR SOME MODERN EQUIVALENT). YOU MAY MAKE AS MANY VERSIONS AS YOU WISH, BUT CHANGE ONLY ONE VARIABLE AT A TIME: EITHER THE NUMBER OF FEATHERS YOU USE OR THE ANGLE AT WHICH THEY ARE SET IN THE CORK.



SUGGESTION: USE A SMALL NAIL TO POKE THE HOLE WHERE YOU WANT THE FEATHERS BEFORE YOU TRY TO INSERT THEM.

WHAT IS THE BEST DESIGN OF A "CORKER-COPTER"?

TO FIND OUT, TEST THE RATE OF FALL OF THE VARIOUS MODELS YOU DESIGN.

A. HOW MANY ROTOR BLADES SHOULD YOUR "CORKER-COPTER" HAVE?

SET THE BLADES (FEATHERS) AT EVEN INTERVALS AROUND THE CORK AND AT THE SAME ANGLE EACH TIME. DROP YOUR COPTER FROM THE SAME HEIGHT FOR EACH TEST. TIME ITS FALL AND FIND THE RATE. REMEMBER- $S = r \cdot t$

HEIGHT OF DROP = ____________ cm   ANGLE OF BLADES = ________

NUMBER OF BLADES	2	3	4	5
TRIAL # 1				
TRIAL # 2				
TRIAL # 3				
TOTAL TIME				
AVERAGE TIME				
RATE OF FALL				

WHICH OF YOUR MODELS SEEMED TO WORK BEST?

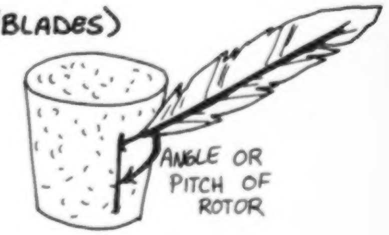
COMPARE YOUR RESULTS WITH YOUR CLASSMATES! WERE THEIR RESULTS THE SAME AS YOURS?

NOW THAT YOU HAVE DECIDED HOW MANY BLADES TO USE, YOU WILL NEED TO DECIDE AT WHAT ANGLE THEY SHOULD BE PLACED. CARRY ON!

______________________ NAME

IT'S A REAL CORKER!

B. AT WHAT ANGLE, OR PITCH, SHOULD YOU PLACE THE ROTORS (BLADES) OF YOUR CORKER COPTER?



BE AS ACCURATE AS YOU CAN WHEN MEASURING THE ANGLES AT WHICH THE FEATHERS ARE SET, THE "PITCH OF THE ROTORS". DROP YOUR CORKER-COPTER FROM THE SAME HEIGHT YOU USED IN PART A. TIME ITS FALL .... Each ADJUSTMENT AND FIND THE RATE.

HEIGHT OF DROP ____________ cm   NUMBER OF BLADES __________

ANGLE OF BLADES				
TRIAL # 1				
TRIAL # 2				
TRIAL # 3				
TOTAL TIME				
AVERAGE TIME				
RATE OF FALL				

WHAT WAS THE OPTIMUM ANGLE FOR PLACING THE BLADES OF YOUR COPTER?

COMPARE YOUR CONCLUSION WITH YOUR CLASSMATES! WERE THEIR RESULTS THE SAME AS YOURS?

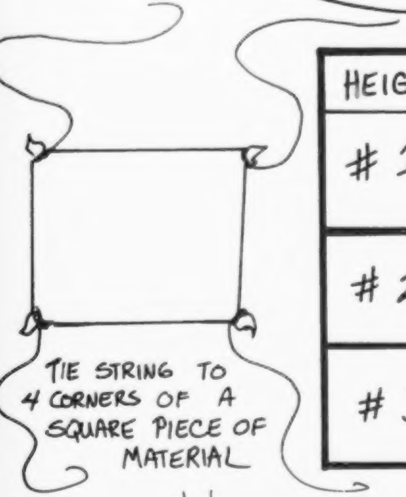
WHAT OTHER FACTORS MIGHT INFLUENCE THE RATE OF FALL OF YOUR CORKER-COPTER?

YOU MAY WANT TO TEST YOUR TEST COPTER DESIGN AGAINST THOSE OF YOUR CLASSMATES. OR YOU MAY WANT TO TRY MAKING A CLASS GRAPH SHOWING HOW MANY STUDENTS SELECTED WHICH NUMBER AND PITCH OF BLADES.

______________________________ NAME

Ah CHUTE!

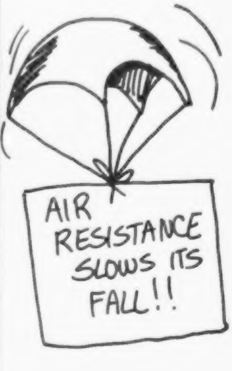
USE ANY MATERIAL YOU WISH TO MAKE A PARACHUTE. DROP IT FROM 3 DIFFERENT HEIGHTS. TIME ITS DESCENT AND COMPUTE YOUR PARACHUTE'S RATE OF DESCENT.



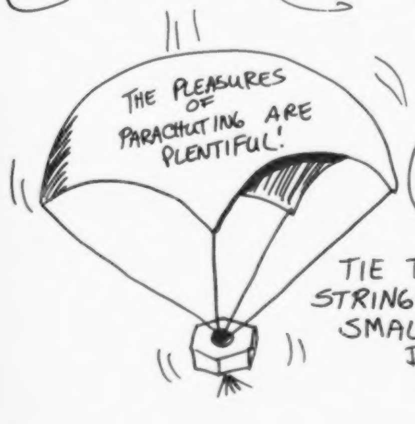
TIE STRING TO 4 CORNERS OF A SQUARE PIECE OF MATERIAL

HEIGHT ÷ TIME = RATE OF FALL

HEIGHT	TRIAL#	HEIGHT	TIME	RATE
# 1	1	m		
	2	m		
# 2	1	m		
	2	m		
# 3	1	m		
	2	m		
		TOTAL		
		(÷6) AVERAGE		



AIR RESISTANCE SLOWS ITS FALL!!



THE PLEASURES OF PARACHUTING ARE PLENTIFUL!

TIE THE 4 STRINGS TO A SMALL NUT AND DROP!

$$\text{RATE OF DESCENT} = \frac{\text{HEIGHT OF DROP IN METERS}}{\text{TIME OF DROP IN SECONDS}}$$

$$r = \frac{d}{t}$$

____________________ NAME

ROCKET BALLOONS

CHART #1

Balloon length vs. Distance Traveled

	Balloon Length	Distance Traveled			Average Distance
		Trial 1	Trial 2	Trial 3	
1.					
2.					
3.					
4.					
5.					

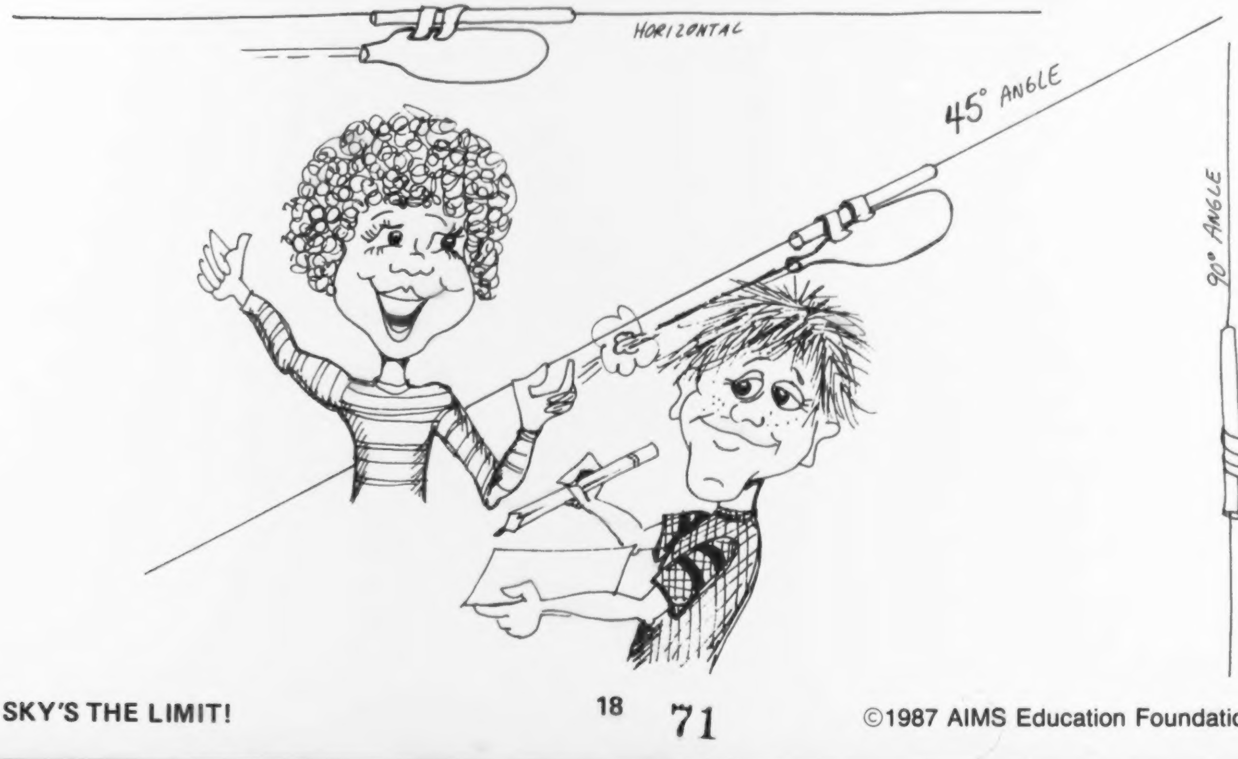
_______________ NAME

ROCKET BALLOONS

CHART # 2

Angle of Flight vs. Distance Traveled

	Balloon Size	Distance Traveled		
		Horizontal	45°	90°
1.				
2.				
3.				
4.				
5.				

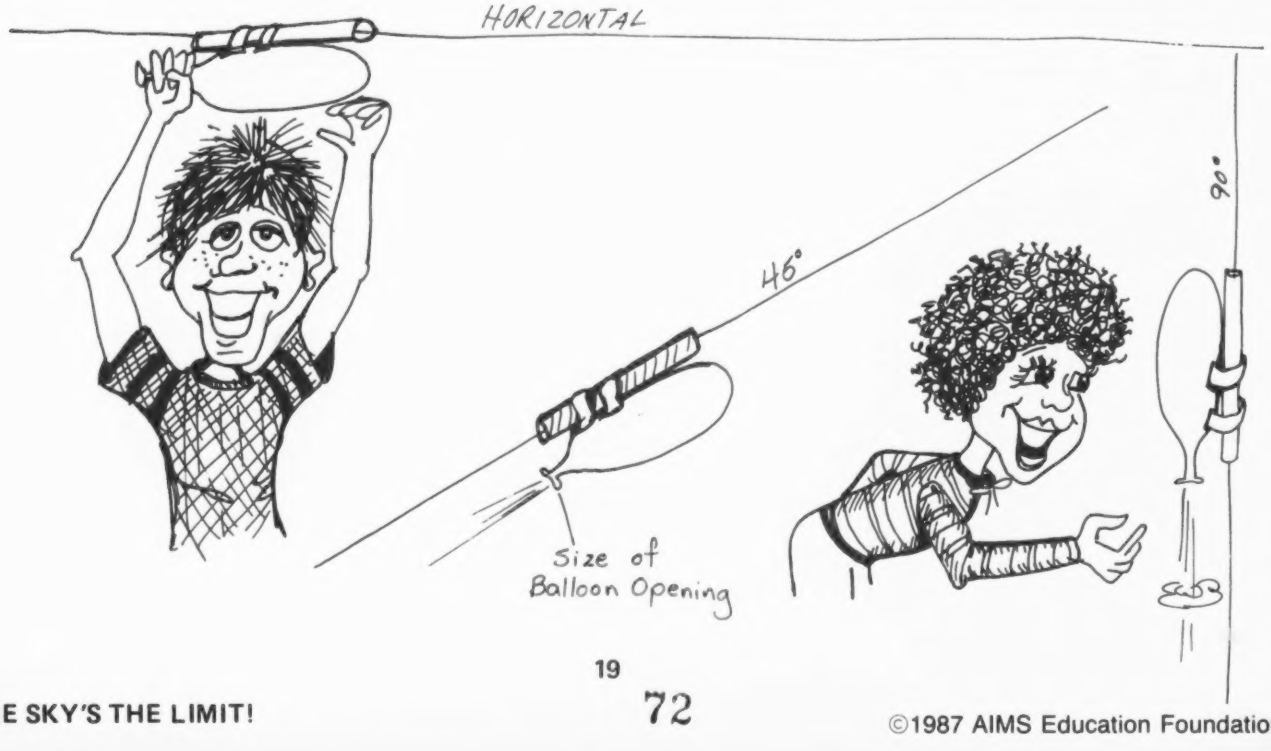

HORIZONTAL
45° ANGLE
90° ANGLE

______________________ NAME

ROCKET BALLOONS

CHART #3

	Balloon Size	Size of Balloon Opening	Distance Traveled		
			Horizontal	45°	90°
1.					
2.					
3.					
4.					
5.					


HORIZONTAL
46°
90°
Size of Balloon Opening

NAME ____________________

HOVER CRAFT

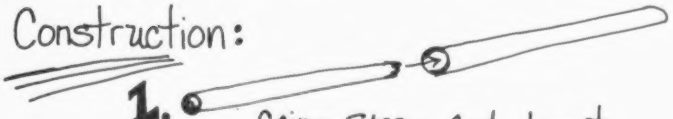
Record Flight Time in Seconds

STRAW LENGTH	cm	cm	cm	cm	cm	cm	cm
FLIGHT #1							
FLIGHT #2							
FLIGHT #3							
TOTAL FLIGHT TIME							
AVERAGE FLIGHT TIME							

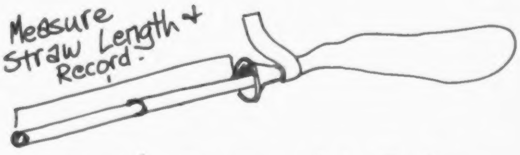
Type of Balloon ____________________ (Round, Sausage, etc)

Longest Flight Time ____________________ (Time Aloft)

Construction:



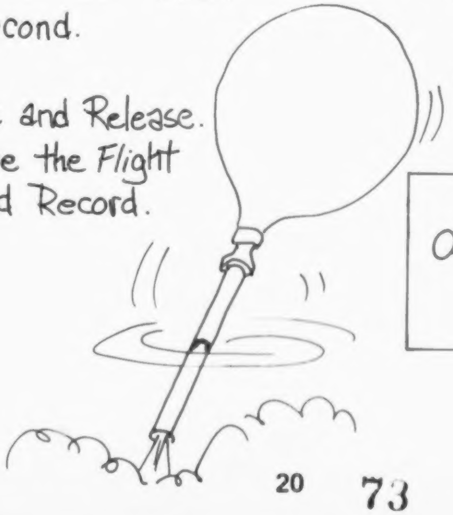
1. Crimp Straw and Insert into second.



2. Measure Straw Length + Record.

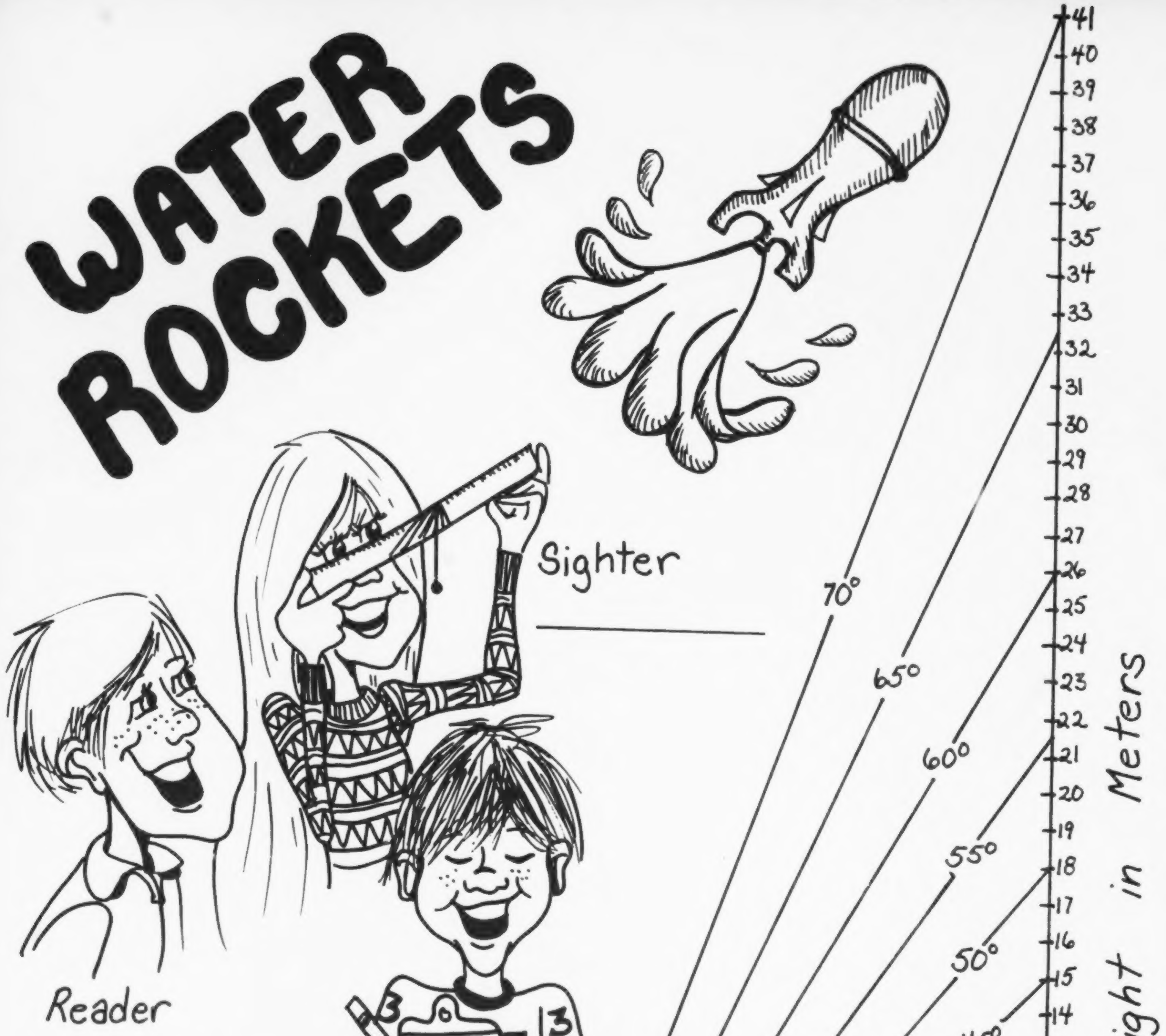
Insert Straws Into Balloon and Tape - No Leaks!

3. Inflate and Release. Time the Flight and Record.



What is The Best Length Of Straw For Your Balloon?

WATER ROCKETS


70°
65°
60°
55°
50°
45°
40°
35°
30°
25°
20°
15°
10°
5°
41
40
39
38
37
36
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Height in Meters
Take Off Point
15 METERS
3
3

Sighter ______________

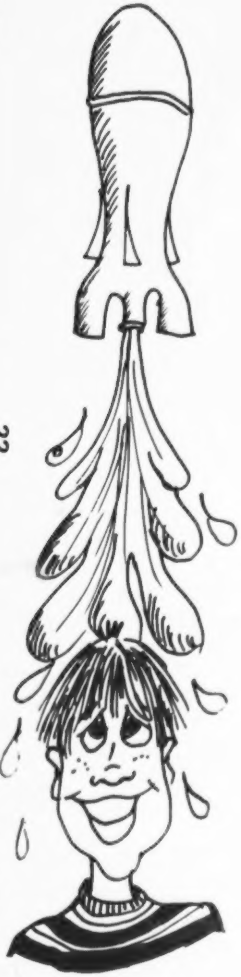
Reader ______________

Recorder ______________

____
Observer's Point

NAME ______________________

WATER ROCKETS



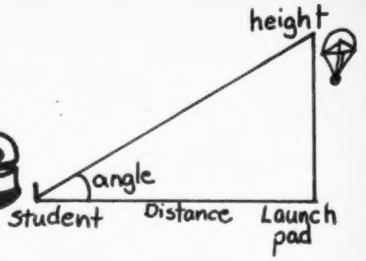
TRIAL NUMBER	VOLUME OF WATER	NUMBER OF PUMPS	ANGLE°	CLASS AVERAGE ANGLE°	ALTITUDE
1	10 ml	5			
2	10 ml	10			
3	10 ml	15			
4	10 ml	20			
5	20 ml	5			
6	20 ml	10			
7	20 ml	15			
8	20 ml	20			
9					
10					

____
NAME

WATER ROCKETS

TRIAL NUMBER	VOLUME OF WATER	NUMBER OF PUMPS	ANGLE	TANGENT OF ANGLE ×	DISTANCE FROM ROCKET =	HEIGHT OF ROCKET
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Tangent of Angle



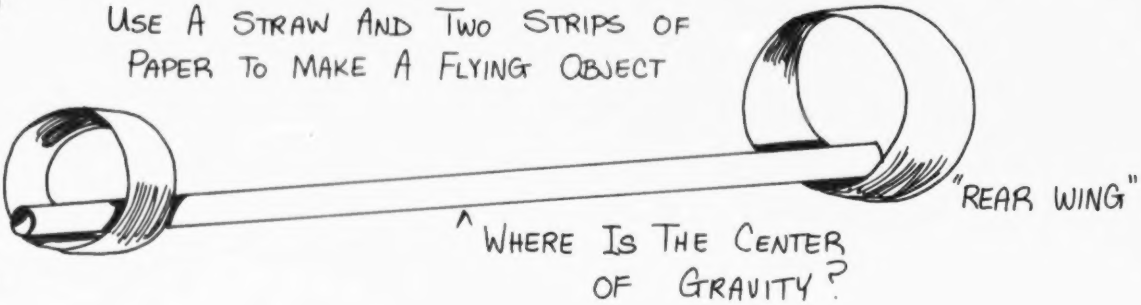
Angle°	Tangent	Angle°	Tangent	Angle°	Tangent
1	.01746	31	.6009	61	1.804
2	.03492	32	.6249	62	1.881
3	.05241	33	.6494	63	1.963
4	.06993	34	.6745	64	2.050
5	.08749	35	.7002	65	2.145
6	.10510	36	.7265	66	2.246
7	.12278	37	.7536	67	2.356
8	.14054	38	.7813	68	2.475
9	.15838	39	.8098	69	2.605
10	.1763	40	.8391	70	2.747
11	.1944	41	.8693	71	2.904
12	.2126	42	.9004	72	3.078
13	.2309	43	.9325	73	3.271
14	.2493	44	.9657	74	3.487
15	.2679	45	1.0000	75	3.732
16	.2867	46	1.0355	76	4.011
17	.3057	47	1.0724	77	4.331
18	.3249	48	1.1106	78	4.705
19	.3443	49	1.1504	79	5.145
20	.3640	50	1.1918	80	5.671
21	.3839	51	1.2349	81	6.314
22	.4040	52	1.2799	82	7.115
23	.4245	53	1.3270	83	8.144
24	.4452	54	1.3764	84	9.514
25	.4663	55	1.4281	85	11.430
26	.4877	56	1.4826	86	14.301
27	.5095	57	1.5399	87	19.081
28	.5317	58	1.6003	88	28.64
29	.5543	59	1.6643	89	57.29
30	.5774	60	1.7321	90	—

Tangent of Angle × Distance from launch = Height

______________________ NAME

It's The Last Straw!

USE A STRAW AND TWO STRIPS OF PAPER TO MAKE A FLYING OBJECT



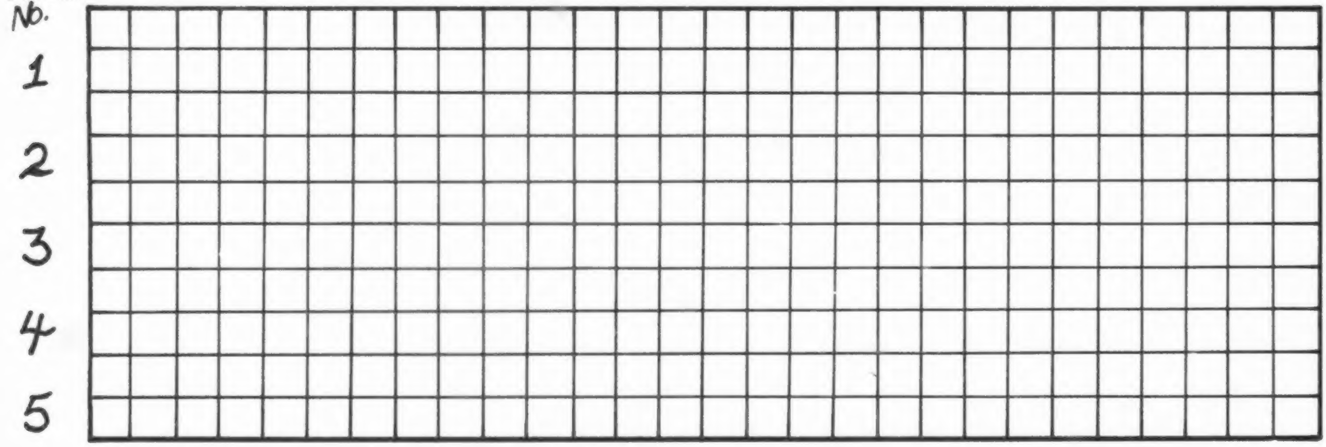
USE THE PATTERNS GIVEN FOR THE STRIPS (A, B, ON NEXT PAGE). CUT OUT AND TAPE TO THE ENDS OF YOUR STRAW AS SHOWN. PRINT YOUR NAME OR THE "PLANES" NAME ON THE REAR WING.

MAKE FIVE TEST FLIGHTS. FOR EACH, MEASURE THE DISTANCE FLOWN IN CENTIMETERS BUT RECORD IN BOTH CENTIMETERS AND METERS.

D I S T A N C E

FLIGHT No.	DISTANCE FLOWN IN CENTIMETERS	METERS
1		
2		
3		
4		
5		
	TOTAL	
	AVERAGE	

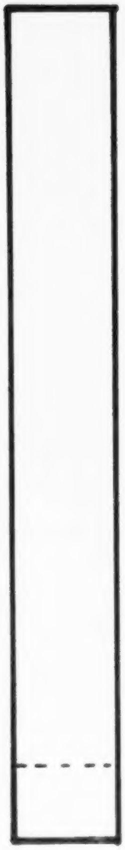
FLIGHT DISTANCE GRAPH



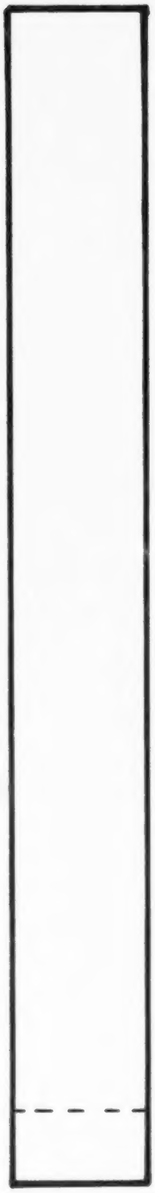
PATTERNS

STRAW PLANE BANDS

A



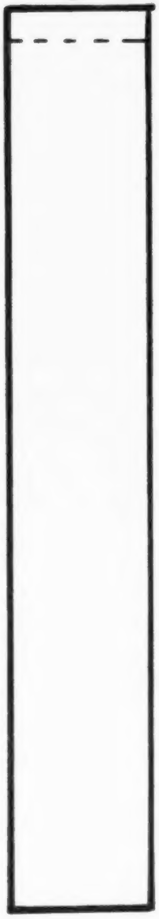
B



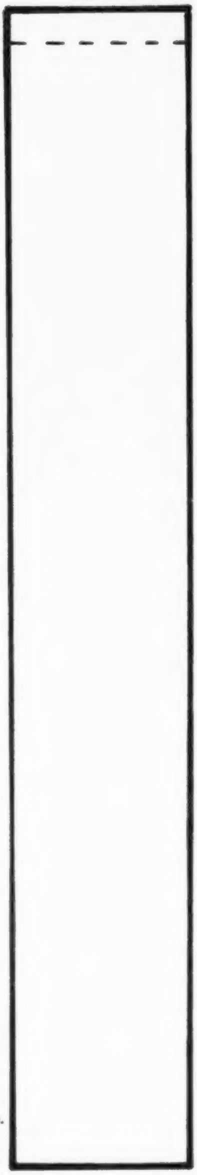
THESE STRIPS WILL CREATE A STRAW PLANE WITHOUT A STRAW!!

THESE PIECES WILL CREATE ANOTHER VERSION OF THE "STRAW PLANE". BANDS C AND D ARE USED IN THE SAME WAY AS IN THE FIRST VERSION.

C

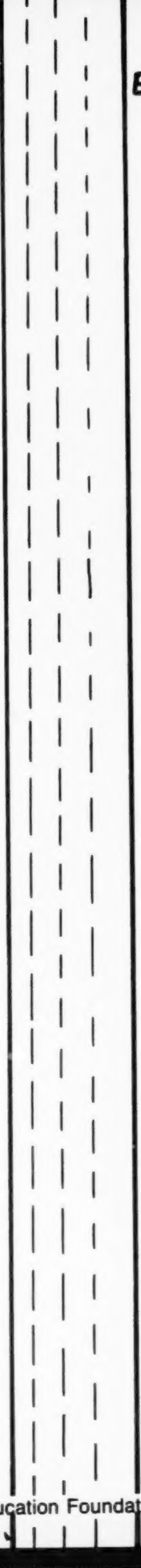


D



BAND E REPLACES THE STRAW. CUT OUT E AND SCORE ALONG DOTTED LINES. OVERLAP 2 SIDES AND GLUE TO FORM A TRIANGULAR ROD. GLUE THE ROD INSIDE THE RINGS.

E



______________ NAME

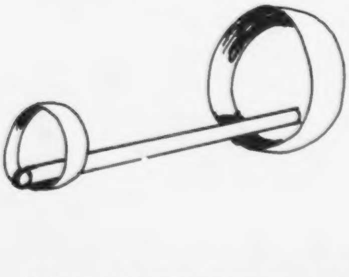
This is Definitely
The Last Straw!

NOW, YOU CAN MODIFY THE BASIC DESIGN IN ANY WAY YOU WISH: MAKE THE BANDS LONGER, SHORTER, WIDER, NARROWER; CHANGE THE CENTER OF GRAVITY OR WHATEVER YOU WISH.

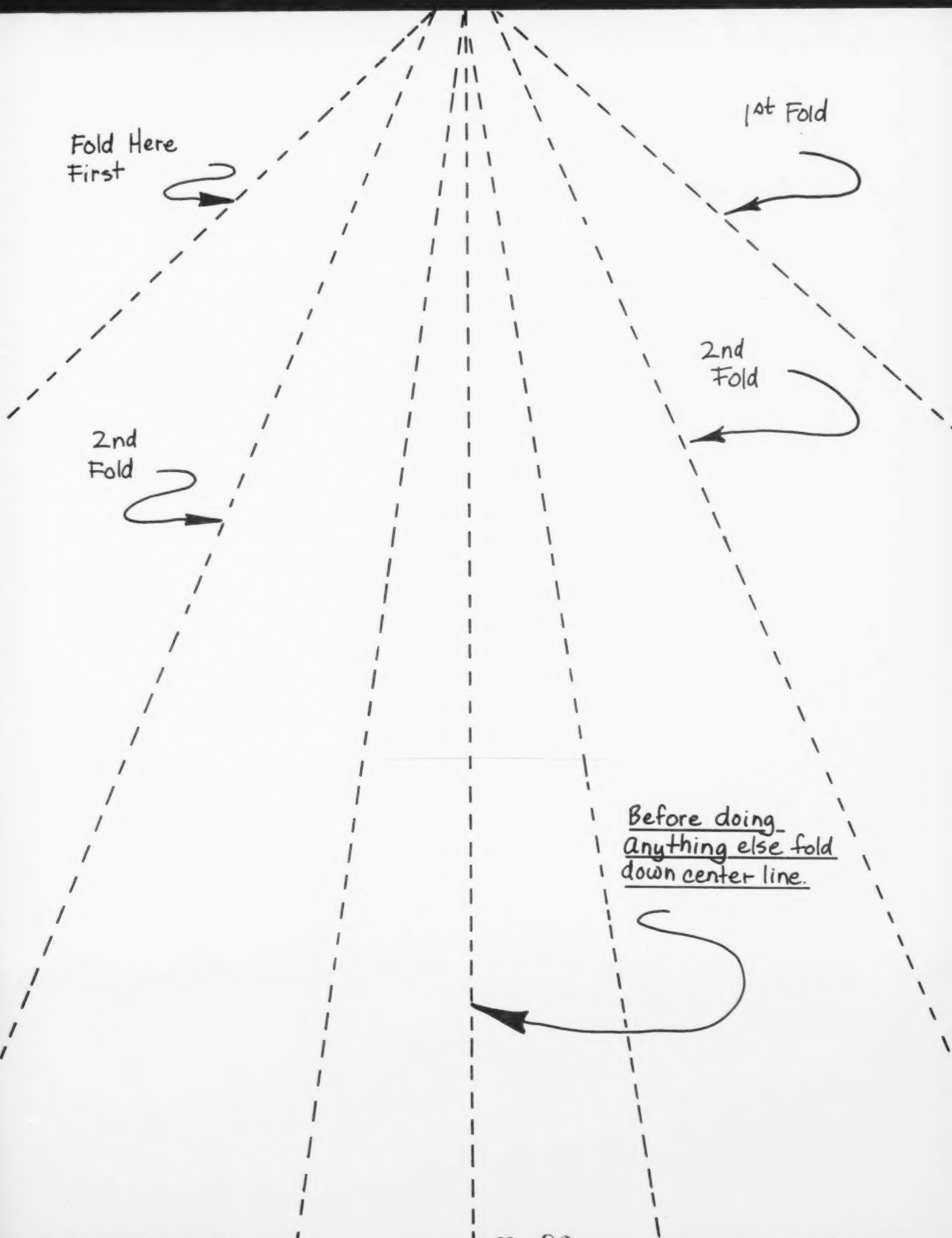
AS YOU WORK, CHOOSE YOUR 2 BEST MODELS AND RECORD THE DESCRIPTIVE INFORMATION BELOW.

MY ORIGINAL MODELS

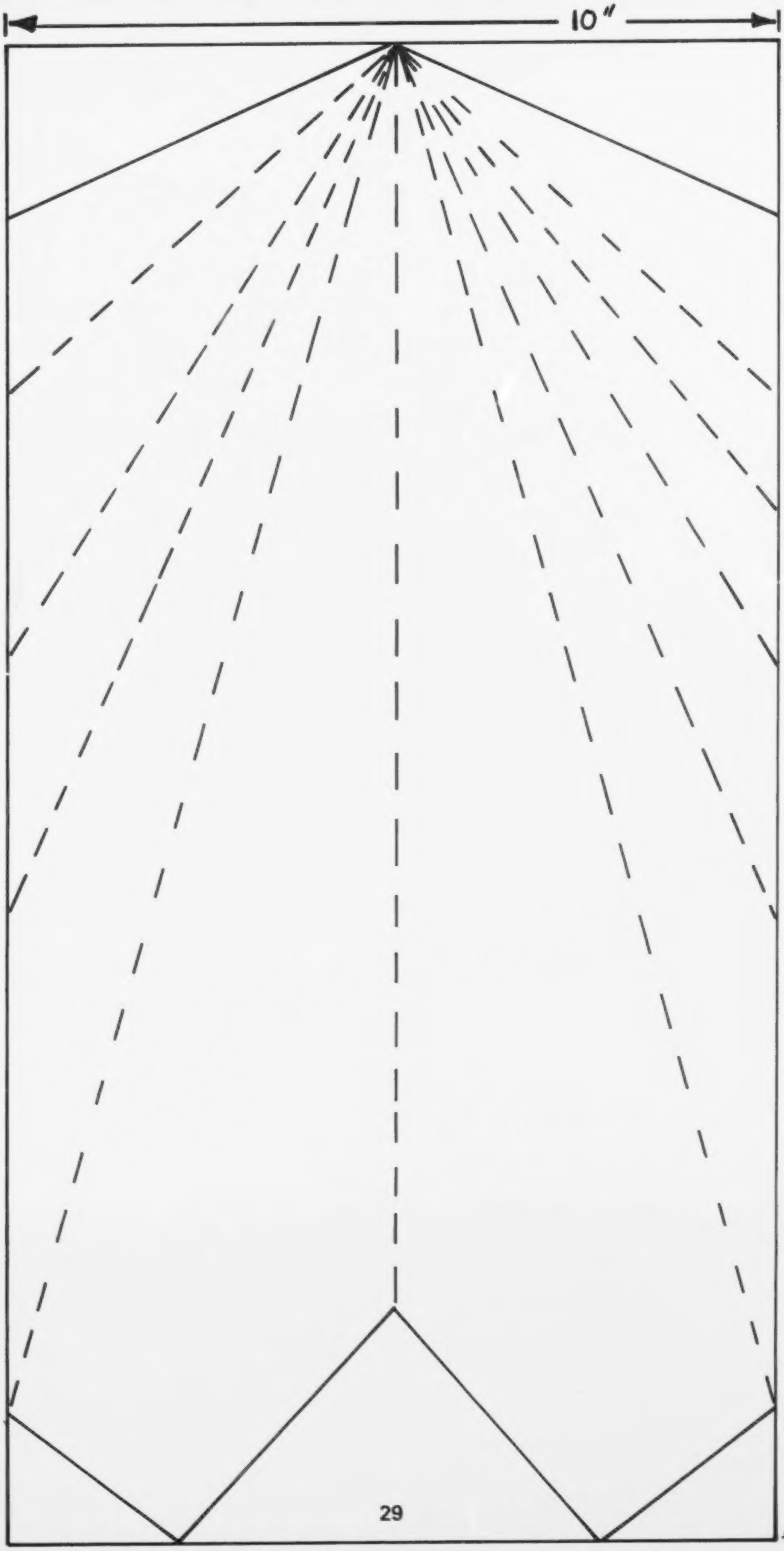
SPECIFICATIONS	MODEL #1	#2
NAME		
LENGTH OF STRAW IN CM		
SHORT BAND LENGTH IN CM		
SHORT BAND WIDTH IN CM		
LONG BAND LENGTH IN CM		
SHORT BAND WIDTH IN CM		
CENTER OF GRAVITY FROM FRONT IN CM		
CENTER OF GRAVITY FROM BACK IN CM		
RECORD DISTANCE FLOWN IN METERS MAKE 5 FLIGHTS OF EACH MODEL	#1	#1
	#2	#2
	#3	#3
	#4	#4
	#5	#5
TOTAL		
AVERAGE		



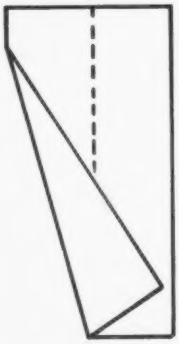
WHAT ARE SOME MODIFICATIONS THAT MIGHT IMPROVE YOUR DESIGN?


1st Fold
Fold Here First
2nd Fold
2nd Fold

Before doing anything else fold down center line.

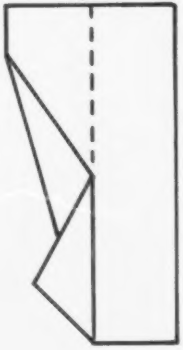


1.



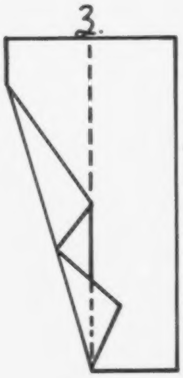
Fold on center Line. Open and make fold as shown.

2.



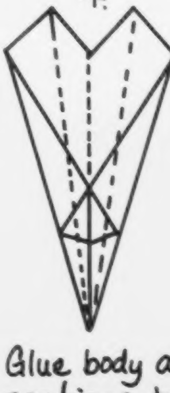
Fold back again at Center line.

3.



And back again. Trim off dart that extends beyond center. Repeat on other half.

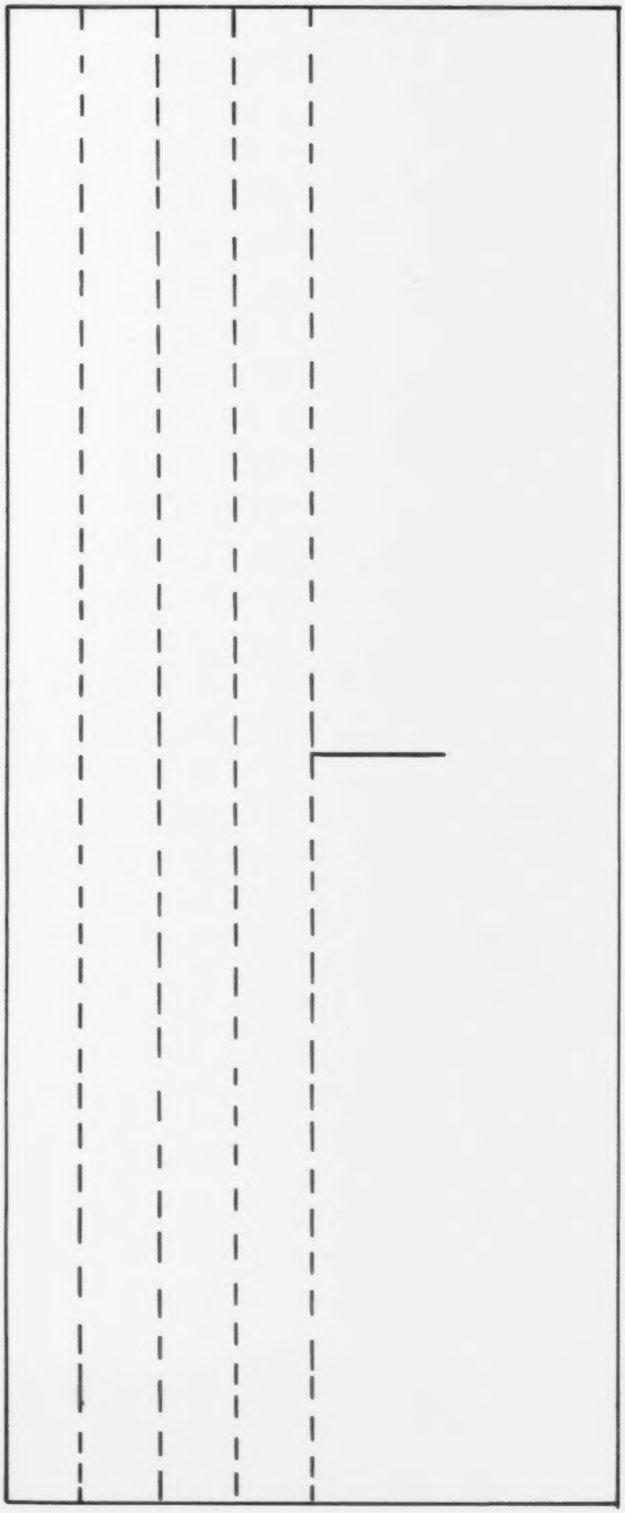
4.



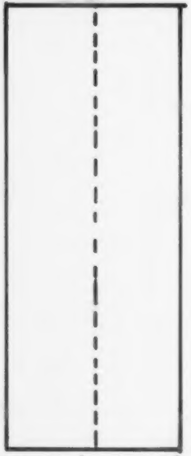
Fold down on center Line and up on Sides.

5. Glue body and all Loose sections together. Trim as indicated. Position wings at an upward angle.

* Can best be made with heavy 10x18 art Paper.

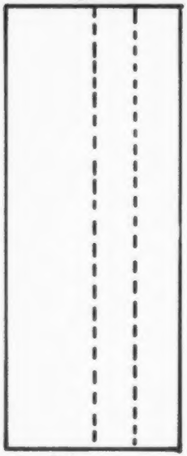


1.



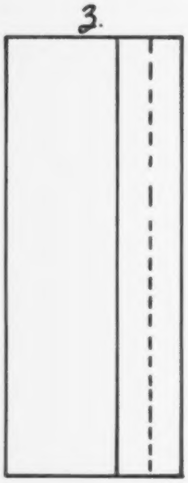
Fold in half
and open
again

2.

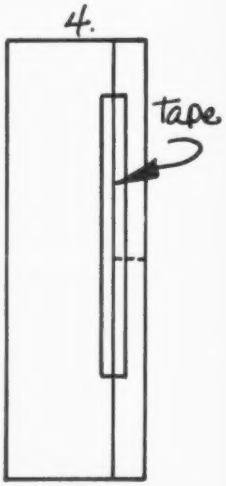


Fold one
side in half

3.

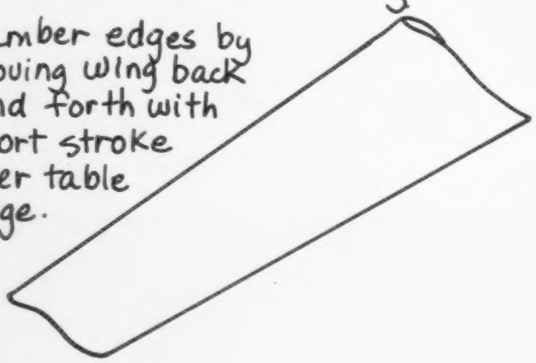


4.

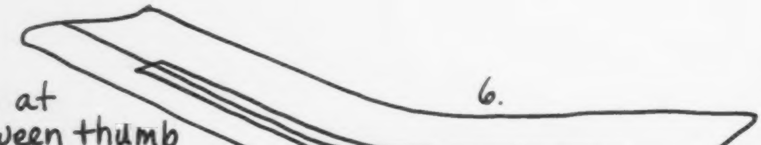


Fold over
again; tape

5.

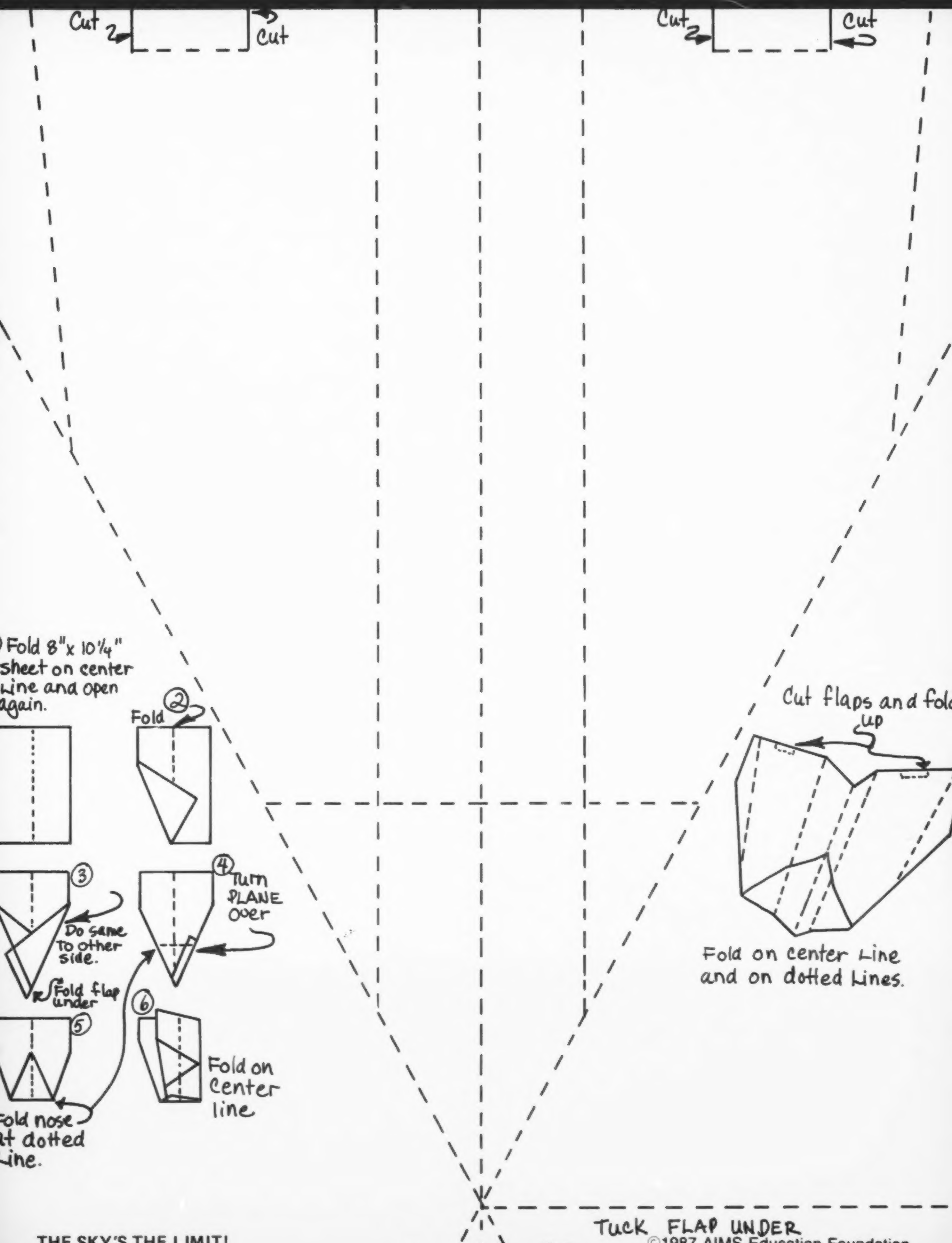


Camber edges by
moving wing back
and forth with
short stroke
over table
edge.



6.

Crease folded section at
center point. Hold between thumb
and forefinger and launch with
gentle horizontal motion



Fold 8"x 10¼" sheet on center line and open again.

Do same to other side.

Fold flap under

Turn PLANE over

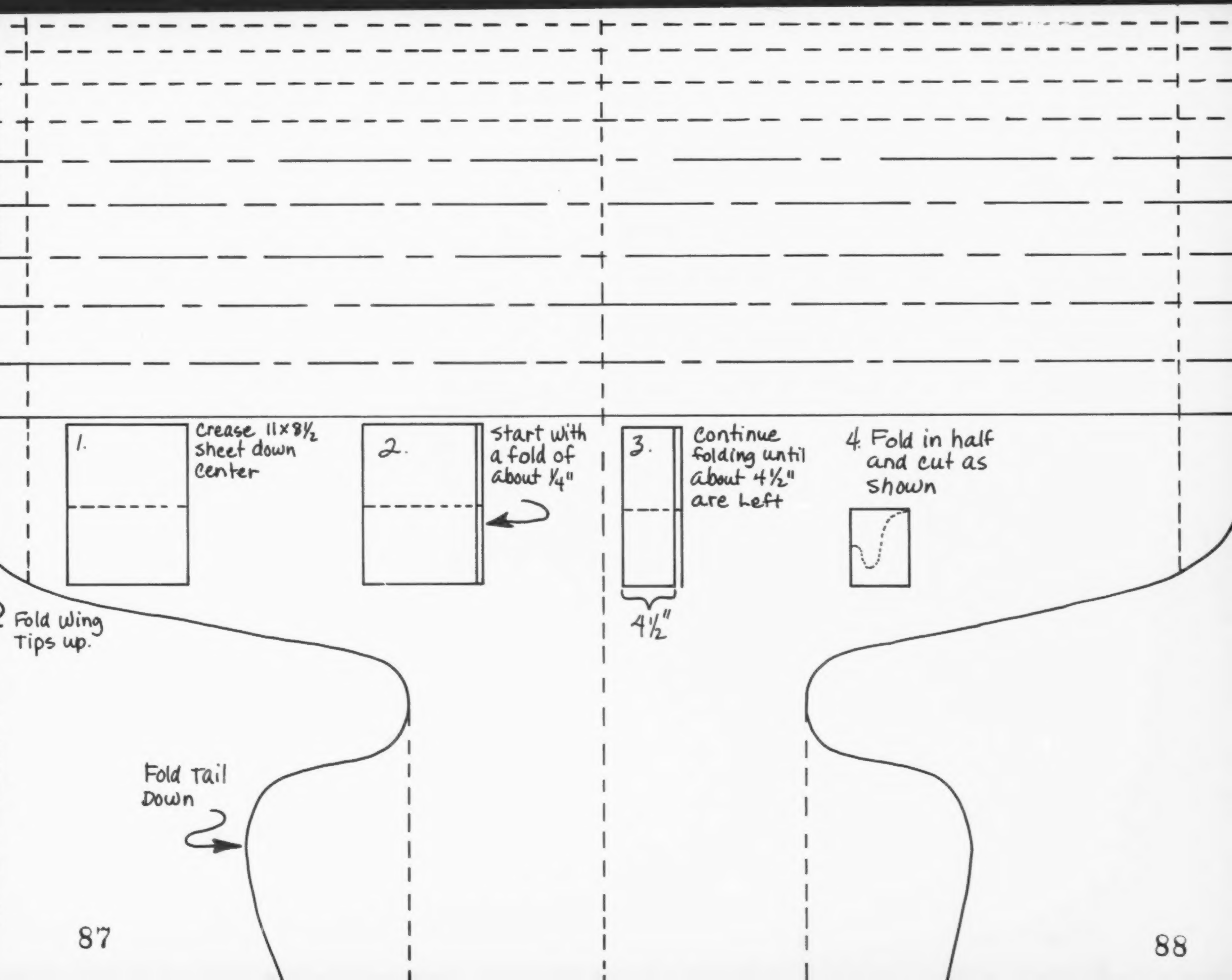
old nose at dotted ine.

Fold on Center line

Cut flaps and fol up

Fold on center Line and on dotted Lines.

TUCK FLAP UNDER



1. Crease 11x8½ sheet down center

2. Start with a fold of about ¼"

3. Continue folding until about 4½" are left

4½"

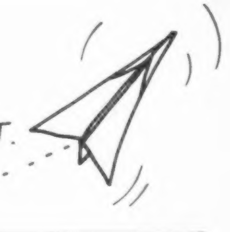
4. Fold in half and cut as shown

Fold Wing Tips up.

Fold Tail Down

______________________ PILOT

Distance Data

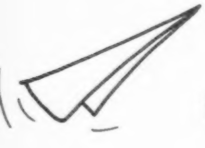


PREDICT WHICH OF YOUR PLANES WILL FLY THE FARTHEST. LIST YOUR PREDICTIONS IN ORDER

		DISTANCE				
PREDICTION	PLANE'S NAME	TRIAL 1	TRIAL 2	TRIAL 3	TOTAL	AVERAGE
1st						
2nd						
3rd						
4th						
5th						

MY BEST PLANE FOR DISTANCE IS ____________.

Group Distance Competition



PICK YOUR BEST PLANE FOR DISTANCE AND COMPETE WITH YOUR AIRWING.

			DISTANCE				
	PILOT	PLANE	TRIAL 1	TRIAL 2	TRIAL 3	TOTAL	AVERAGE
1.							
2.							
3.							
4.							
5.							
6.							

(BEST AVERAGE DISTANCE)

PILOT	PLANE	DISTANCE

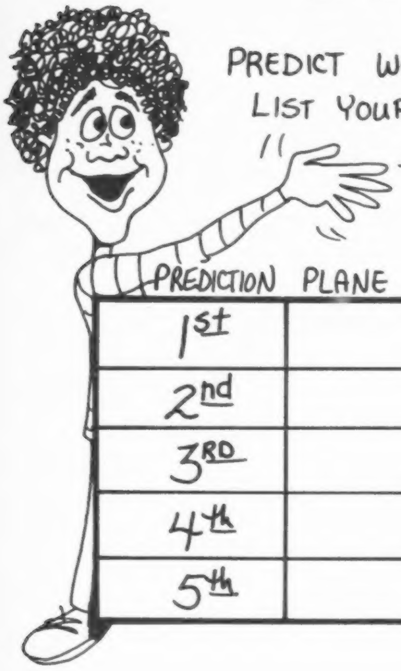
(BEST DISTANCE)

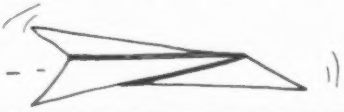
PILOT	PLANE	DISTANCE

Length Aloft (FLIGHT TIME)

____________________ PILOT

PREDICT WHICH OF YOUR PLANES WILL STAY ALOFT THE LONGEST. LIST YOUR PREDICTIONS IN ORDER.





		TIME ALOFT IN SECONDS				
PREDICTION	PLANE	TRIAL 1	TRIAL 2	TRIAL 3	TOTAL	AVERAGE
1st						
2nd						
3RD						
4th						
5th						

MY BEST PLANE FOR TIME ALOFT IS ____________________.

Length Aloft Competition

PICK YOUR BEST PLANE FOR LENGTH ALOFT AND COMPETE WITH YOUR AIRWING.

		TIME ALOFT IN SECONDS				
PILOT	PLANE	TRIAL 1	TRIAL 2	TRIAL 3	TOTAL	AVERAGE

BEST AVERAGE

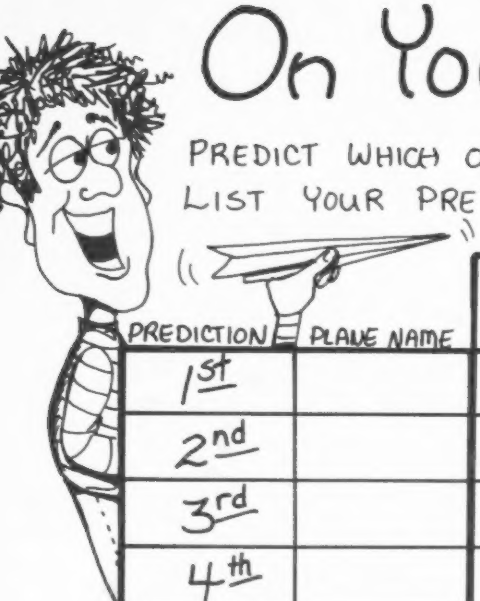
PILOT	PLANE	TIME

BEST LENGTH ALOFT

PILOT	PLANE	TIME

______________ PILOT

On Your Mark - Accuracy



PREDICT WHICH OF YOUR PLANES WILL FLY THE MOST ACCURATELY. LIST YOUR PREDICTIONS IN ORDER.

PREDICTION	PLANE NAME	DISTANCE FROM TARGET CENTER				
		TRIAL 1	TRIAL 2	TRIAL 3	TOTAL	AVERAGE
1st						
2nd						
3rd						
4th						
5th						

MY BEST PLANE FOR ACCURACY IS______________.

Group Accuracy Competition

PICK YOUR BEST PLANE FOR ACCURACY AND COMPETE WITH YOUR AIRWING.

PILOT	PLANE	DISTANCE FROM TARGET CENTER				
		TRIAL 1	TRIAL 2	TRIAL 3	TOTAL	AVERAGE

(BEST AVERAGE)

PILOT	PLANE	DISTANCE OFF TARGET

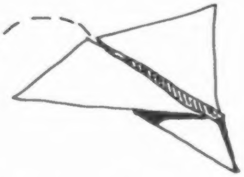
(MOST ACCURATE FLIGHT)

PILOT	PLANE	DISTANCE OFF TARGET

________________ PILOT

Train Your Plane

Aerobatics

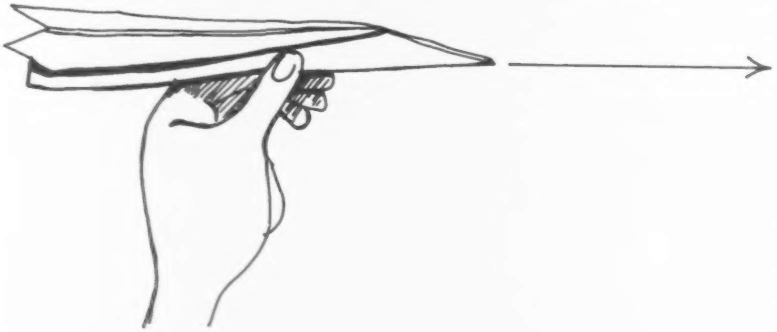


CHOOSE ONE OF YOUR 5 PLANES THAT YOU THINK WILL BE ABLE TO DO THESE STUNTS.

CAN YOU MAKE YOUR PLANE ......

	YES	NO
FLY STRAIGHT	______	______
CLIMB	______	______
DIVE	______	______
BANK LEFT	______	______
BANK RIGHT	______	______
LOOP	______	______
DOUBLE LOOP	______	______
BOOMERANG	______	______

☆ RULE: ALL PLANES MUST BE LAUNCHED HORIZONALLY. ☆



WHICH OF THESE ACROBATIC FEATS DID YOUR PLANE DO BEST?

____

WHAT DID YOU DO TO YOUR PLANE IN ORDER TO ACHIEVE THIS?

____

____

AVIATION ALPHABET

A	Alpha
B	Bravo
C	Charlie
D	Delta
E	Echo
F	Foxtrot
G	Golf
H	Hotel
I	India
J	Juliet
K	Kilo
L	Lima
M	Mike
N	November
O	Oscar
P	Papa
Q	Quebec
R	Romeo
S	Sierra
T	Tango
U	Uniform
V	Victor
W	Whiskey
X	X-Ray
Y	Yankee
Z	Zulu

Name your plane. Start your identification with N (which stands for United States), then numbers and letters not to exceed a total of 7.

Example N 952 - SM
November 952 Sierra Mike

N 231 BC
November 231 Bravo Charlie

AIR FAIR → MASTER SCORE SHEETS

PILOT	EVENT 1 DISTANCE	EVENT 2 FLIGHT TIME	EVENT 3 ACCURACY	EVENT 4 AEROBATICS	SCORE
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
32.					
33.					
34.					
35.					
36.					

EVENT # 1 DISTANCE

ENTRY CARD

PILOT ____________________

PLANE ____________________

____
DISTANCE OF FLIGHT

AIR FAIR

PLACE FINISH ________

POINTS ________

EVENT # 2 FLIGHT TIME

ENTRY CARD

PILOT ____________________

PLANE ____________________

____
FLIGHT TIME IN SECONDS

AIR FAIR

PLACE FINISH ________

POINTS ________

EVENT # 3 ACCURACY

ENTRY CARD

PILOT ____________________

PLANE ____________________

____
MEASUREMENT

AIR FAIR

PLACE FINISH ________

POINTS ________

EVENT # 4 AEROBATICS

ENTRY CARD

PILOT ____________________

PLANE ____________________

FLY STRAIGHT ______

CLIMB ______

DIVE ______

BANK RIGHT ______

BANK LEFT ______

ROLL ______

LOOP ______

DOUBLE LOOP ______

BOOMERANG ______

POINTS ________

AIR FAIR

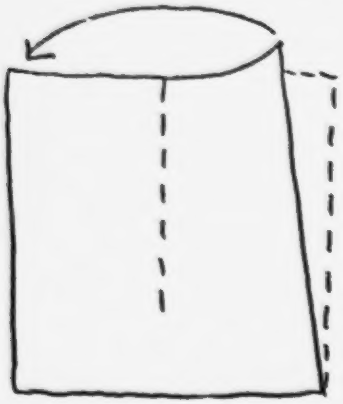
A PAPERFOLD KITE

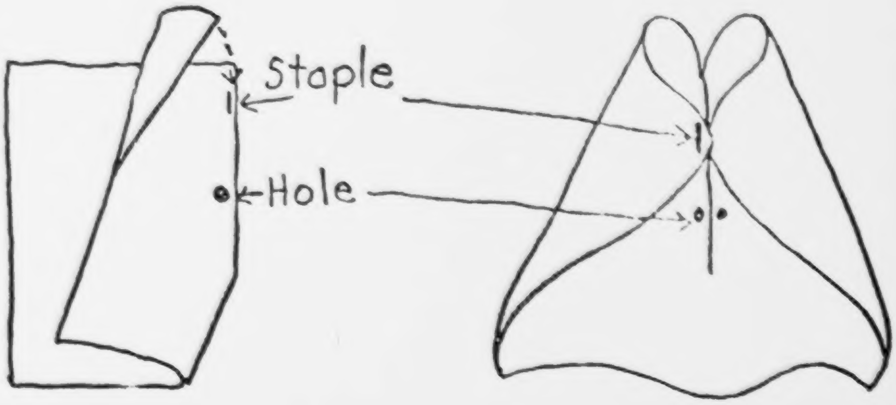
All students should know about a folded paper kite. There is nothing like it for lifting the spirit. You can design, produce, and have a paper kite airborne in a couple of minutes. All you need is a sheet of paper (typewriter bond in fine), a small stapler, scissors, and a spool of sewing thread.

One of the best designs has the triangular shape of the paper darts or gliders every schoolboy makes. It has no sticks, fins, rudders, tails, stablizers, or other structural additions. Nor is the design violently precise, for the kite can be made from either a square or oblong piece of paper, from about 8 by 8 inches on up. The proportion of width to length should not exceed 4 to 3, but square is optimum.

The kite requires one center fold. If your paper is rectangular, begin folding so that the short sides meet, but take care to crease the paper for only a bit more than half the distance. With that fold as the basic keel, bend down (don't crease) the front two corners of the sheet so that they meet outside the fold, at the keel, about an inch back from the nose. Line them up neatly and staple them to and through the keel.

Next, mark a spot on the keel about a half inch forward of the midpoint. Punch a hole there with a hole-punch. Tie the thread to the kite at this point. You are now ready to fly your kite.





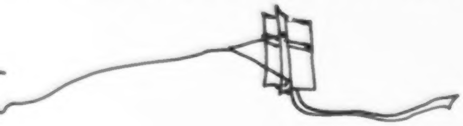
________ NAME

DUTCH KITE

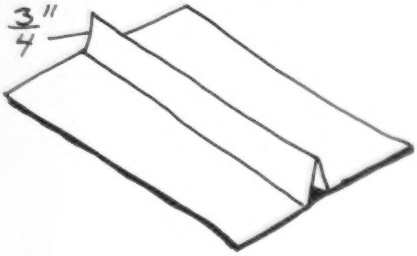
THE DUTCH KITE INCORPORATES THE BASIC ELEMENTS NEEDED FOR FLIGHT----A SPINE, A CROSSPIECE, A BRIDLE TO HOLD THE KITE FACE TO THE WIND, AND A TAIL FOR STABILITY. IT FLIES EASILY IN LIGHT BREEZES OR HEAVY WINDS. IT IS A TOLERANT KITE AND EVEN THOUGH A LESS THAN PERFECT MODEL, WILL STILL FLY.

MATERIALS NEEDED:
1. STIFF PAPER ($8\frac{1}{2}$" X 11" DITTO OR TYPING PAPER IS GREAT)
2. ELMERS GLUE
3. PAPER HOLE-PUNCH
4. CREPE PAPER FOR TAIL (A STRIP 1" WIDE BY 4' LONG IS ADEQUATE)
5. SPOOL OF SEWING THREAD

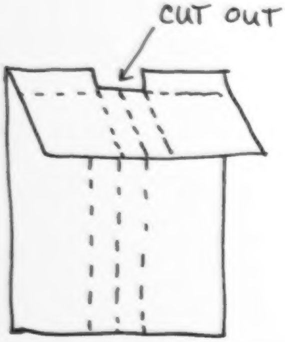
MAKING THE KITE

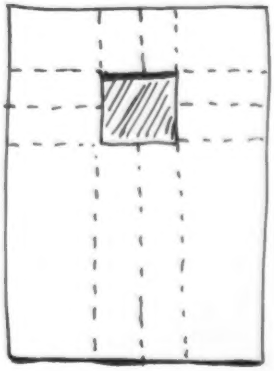


1. FOLD AND CREASE THE PAPER LONGWAY. FOLD AND CREASE AGAIN, 3/4" FROM CENTER FOLD. OPEN SO THE FOLDED SECTION FORMS A RIDGE UP THE MIDDLE. THIS WILL BE THE FRONT OF THE KITE.



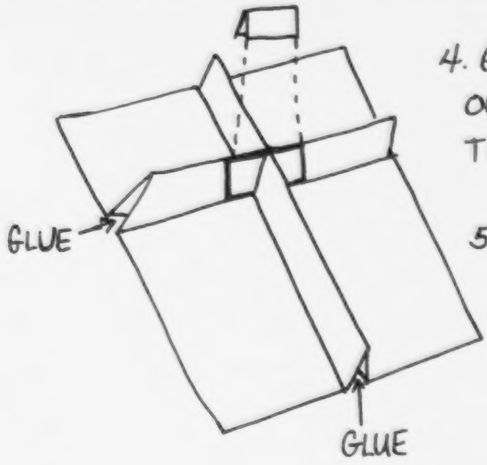
2. OPEN PAPER FLAT. FOLD AND CREASE ON A LINE 3" FROM THE TOP (SHORT WAY). FOLD AND CREASE 3/4" FROM THIS FOLD. UNFOLD THIS CREASE AND CUT ON THE HEAVILY MARKE LINES AT THE TOP. OPEN PAPER FLAT, BACK SIDE UP.





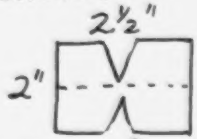
DUTCH KITE - pg. 2

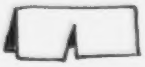
3. PUT GLUE ON THE TOP AND BOTTOM SECTIONS OF THE LONG MIDDLE FOLD, (BETWEEN THE FOLD LINES), BUT NOT ON THE CROSS FOLDED SECTION WHERE THE CUT-OUT PART IS. FOLD IN CENTER, SPREADING SIDES OUT FLAT, THUS GLUING THE SPINE OF THE KITE. NOW GLUE THE 2 CROSS SECTIONS AT TOP.



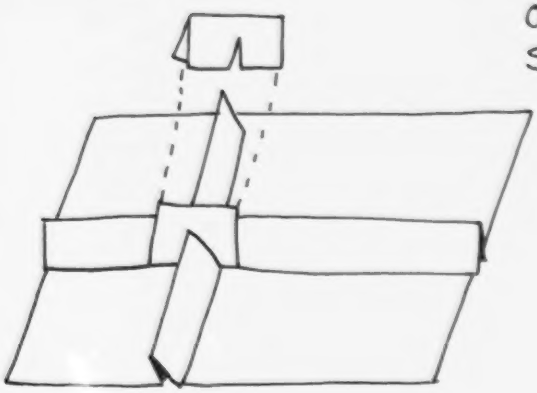
4. GLUE THE SQUARE PIECE OF PAPER YOU CUT OUT (IN STEP 2) SO THAT IT JOINS TOGETHER THE 2 TOP CROSS SECTIONS.

5. TAKE A SCRAP PIECE OF PAPER (2" X 2½") AND FOLD IN THE MIDDLE, ACROSS THE 2" DIMENSION.

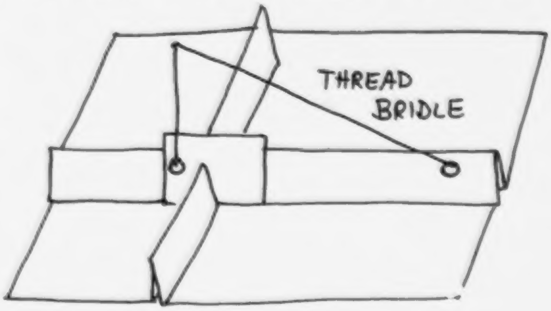


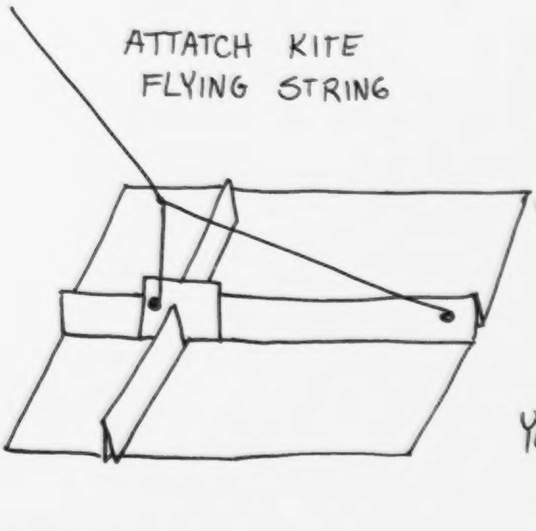


CUT A SLIT ¾" HIGH THROUGH THE CENTER OF THE PAPER. GLUE THIS TO THE LONG CENTER SPINE TO CONNECT THE SPINES TOGETHER.



6. PUNCH TWO HOLES FOR THE BRIDLE.





7. GLUE THE 1" x 4' TAIL OF CREPE PAPER TO THE BACK OF THE KITE.

YOUR KITE IS READY TO FLY!

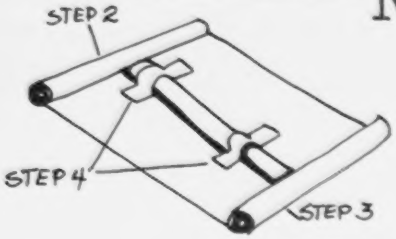
______________________ NAME

3-STRAW KITE

OFTEN, WE FORGET THAT KITES NEED NOT BE COMPLEX OR EXPENSIVE. HERE IS A KITE DESIGN THAT IS BOTH SIMPLE AND EFFICIENT. BEST OF ALL, THE COST IS QUITE LOW!

MATERIALS NEEDED:
- 2 SHEETS OF PAPER
- 3 PLASTIC STRAWS
- WHITE GLUE OR RUBBER CEMENT
- TAPE
- KITE STRING OR THREAD

MAKING THE KITE



STEP 1. CUT PAPER TO SIZE AS FOLLOWS:
LENGTH = LENGTH OF STRAW + 6 cm
WIDTH = LENGTH OF STRAW.

STEP 2. FOLD & GLUE TOP EDGE OF PAPER OVER A STRAW.

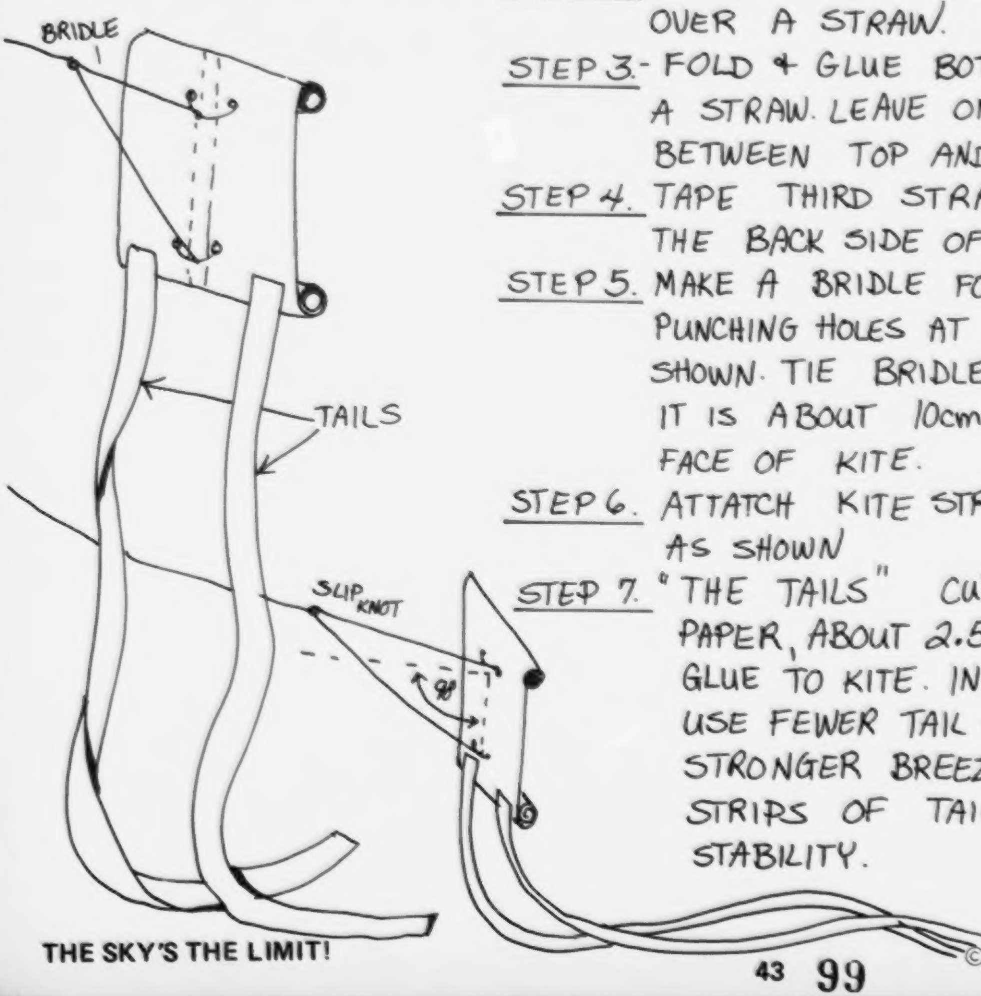
STEP 3. - FOLD & GLUE BOTTOM EDGE OVER A STRAW. LEAVE ONE STRAW LENGTH BETWEEN TOP AND BOTTOM.

STEP 4. TAPE THIRD STRAW IN PLACE ON THE BACK SIDE OF KITE.

STEP 5. MAKE A BRIDLE FOR THE KITE BY PUNCHING HOLES AT THE POSITIONS SHOWN. TIE BRIDLE STRING SO THAT IT IS ABOUT 10cm to 15cm FROM FACE OF KITE.

STEP 6. ATTATCH KITE STRING TO BRIDLE AS SHOWN

STEP 7. "THE TAILS" CUT STRIPS OF PAPER, ABOUT 2.5 cm WIDE AND GLUE TO KITE. IN LIGHT BREEZES, USE FEWER TAIL SECTIONS. IN STRONGER BREEZES, USE MORE STRIPS OF TAIL FOR ADDED STABILITY.



______________ NAME

Go Fly A Kite Recording Chart

Altitude of Kite

LENGTH OF KITE STRING USED IN FLYING

KITE WEIGHT ______________

DATE OF FLIGHT ______________

WIND DIRECTION ______________

WIND SPEED ______________

CHART A

Ranged Distance to Kite, or Length of Line (Meters)

ANGLE (DEGREES) TO KITE

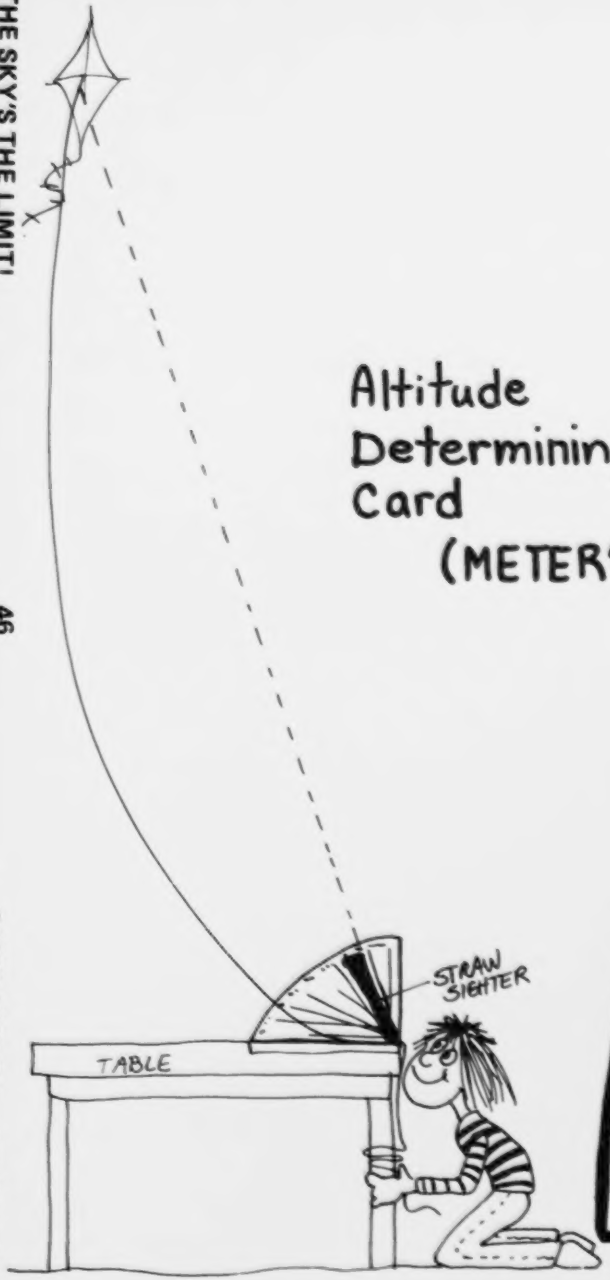
ALTITUDE OF KITE (METERS)

	10m	15m	20m	25m	30m	35m	40m	45m	50m	75m	100 m
5°	.8	1.3	1.7	2.2	2.6	3	3.4	3.9	4.3	6.4	8.6
10°	1.7	2.6	3.4	4.3	5.2	6	6.8	7.8	8.7	12.8	17.4
15°	2.5	3.9	5	6.4	7.8	9	10	11.6	12.9	19.3	25
20°	3.5	5.1	7	8.5	10.3	12	14	15.3	17	25.6	34
25°	4.2	6.3	8.4	10.5	12.6	14.7	16.8	19	21.1	31.6	42.2
30°	5	7.5	10	12.5	15	17.5	20	22.5	25	37.5	50
35°	5.7	8.4	11.4	14.2	16.9	19.9	22.8	25.6	28.6	42.8	57
40°	6.4	9.5	12.8	15.9	19.0	22.3	25.6	28.5	32	48	64
45°	7	10.6	14	17.6	21.2	24.7	28	31.8	35	52.8	70.7
50°	7.7	11.5	14.5	19.1	23	26.8	29	34.5	38.3	57.4	76.6
55°	8.1	12.3	16.2	20.4	24.6	28.6	32.4	37.8	40.6	61.2	81
60°	8.6	12.9	17.2	21.6	25.9	30.3	34.8	38.9	43	64.8	86
65°	9	13.6	18	22.6	27.3	31.7	36	40.8	45.1	67.8	90.6
70°	9.3	14	18.7	23.4	27.9	32.8	37.4	42.2	47	70.4	94
75°	9.6	14.4	19.2	24.1	28.8	33.8	38.5	43.4	48.2	72.4	96.5
80°	9.8	14.7	19.6	24.6	29.5	34.4	39.3	44.2	49.2	73.8	98
85°	9.9	14.9	19.8	24.7	29.7	34.7	39.6	44.6	49.5	74.4	99
90°	10	15	20	25	30	35	40	45	50	75	100

101

102

Altitude Determining Card (METERS)


STRAW SIGHTER
TABLE

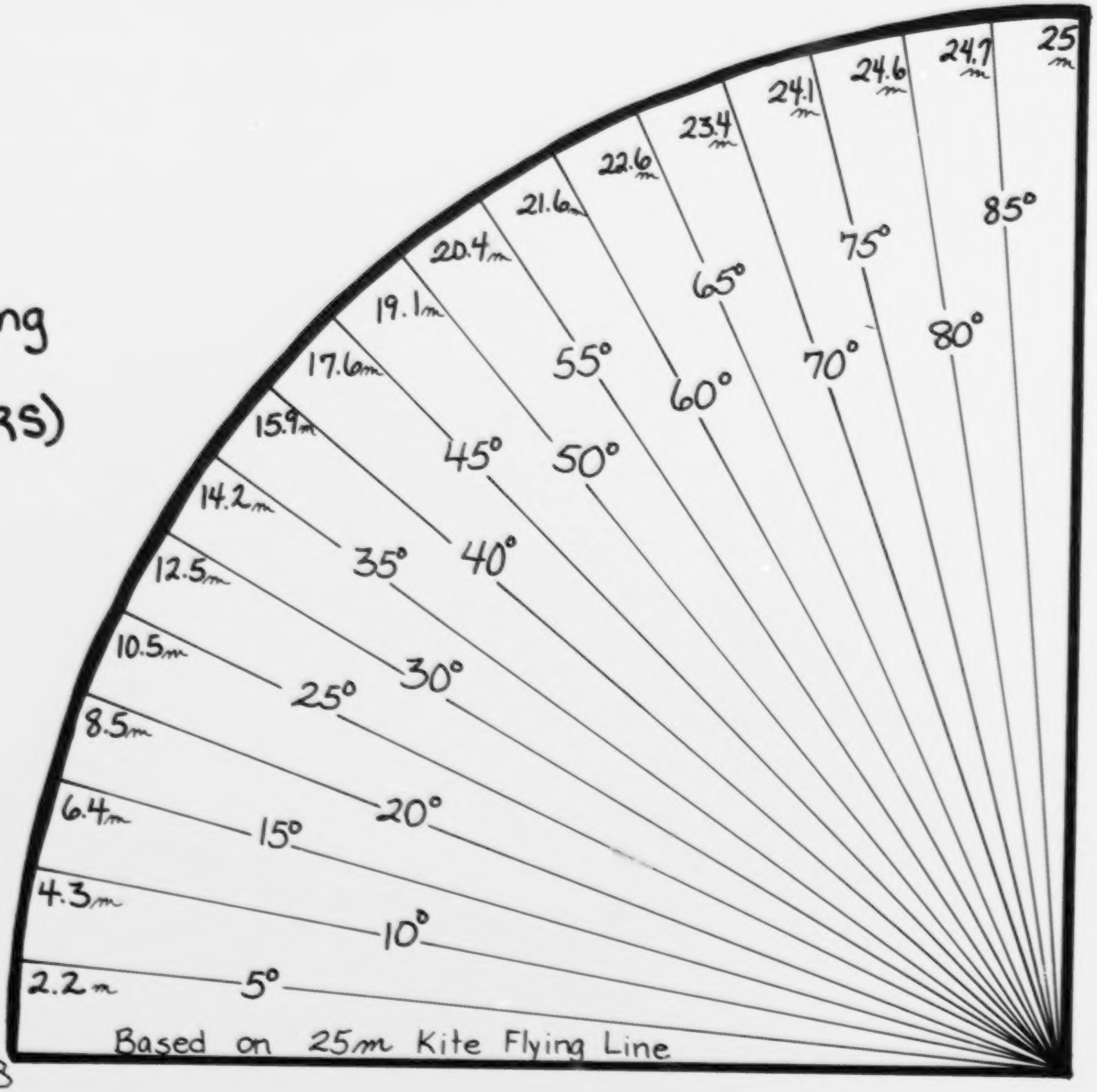
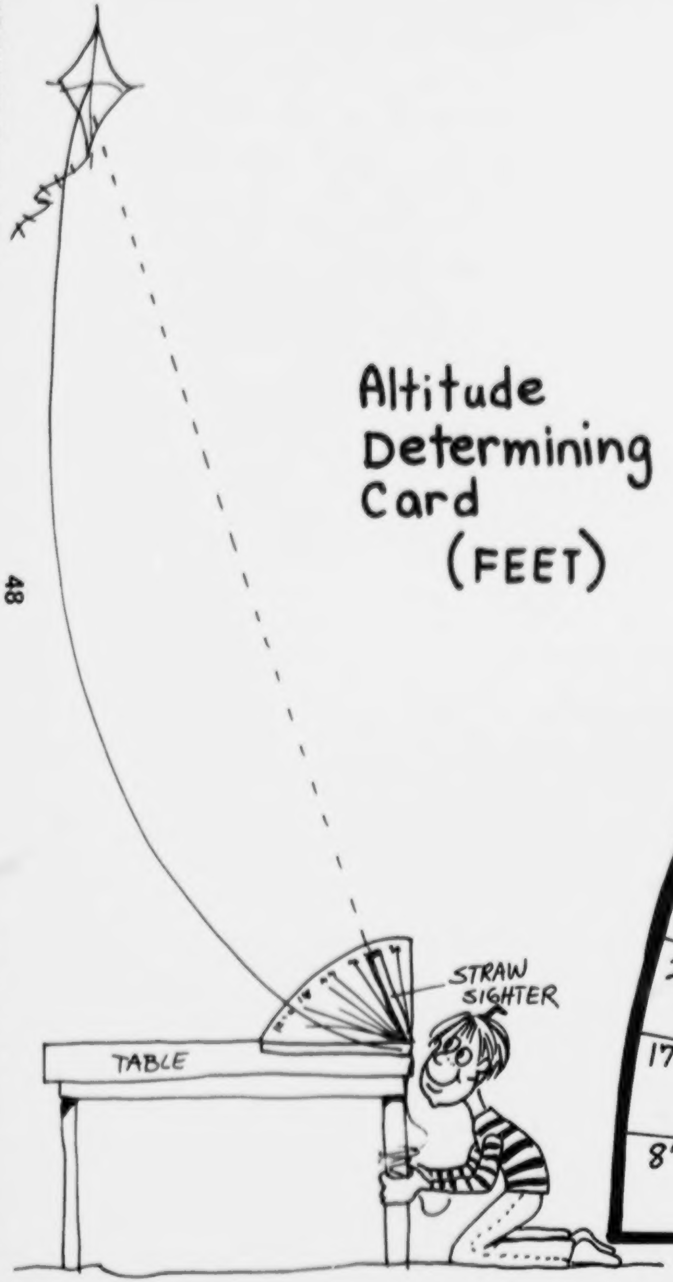

2.2 m
4.3 m
6.4 m
8.5 m
10.5 m
12.5 m
14.2 m
15.9 m
17.6 m
19.1 m
20.4 m
21.6 m
22.6 m
23.4 m
24.1 m
24.6 m
24.7 m
25 m
5°
10°
15°
20°
25°
30°
35°
40°
45°
50°
55°
60°
65°
70°
75°
80°
85°
Based on 25m Kite Flying Line

CHART B

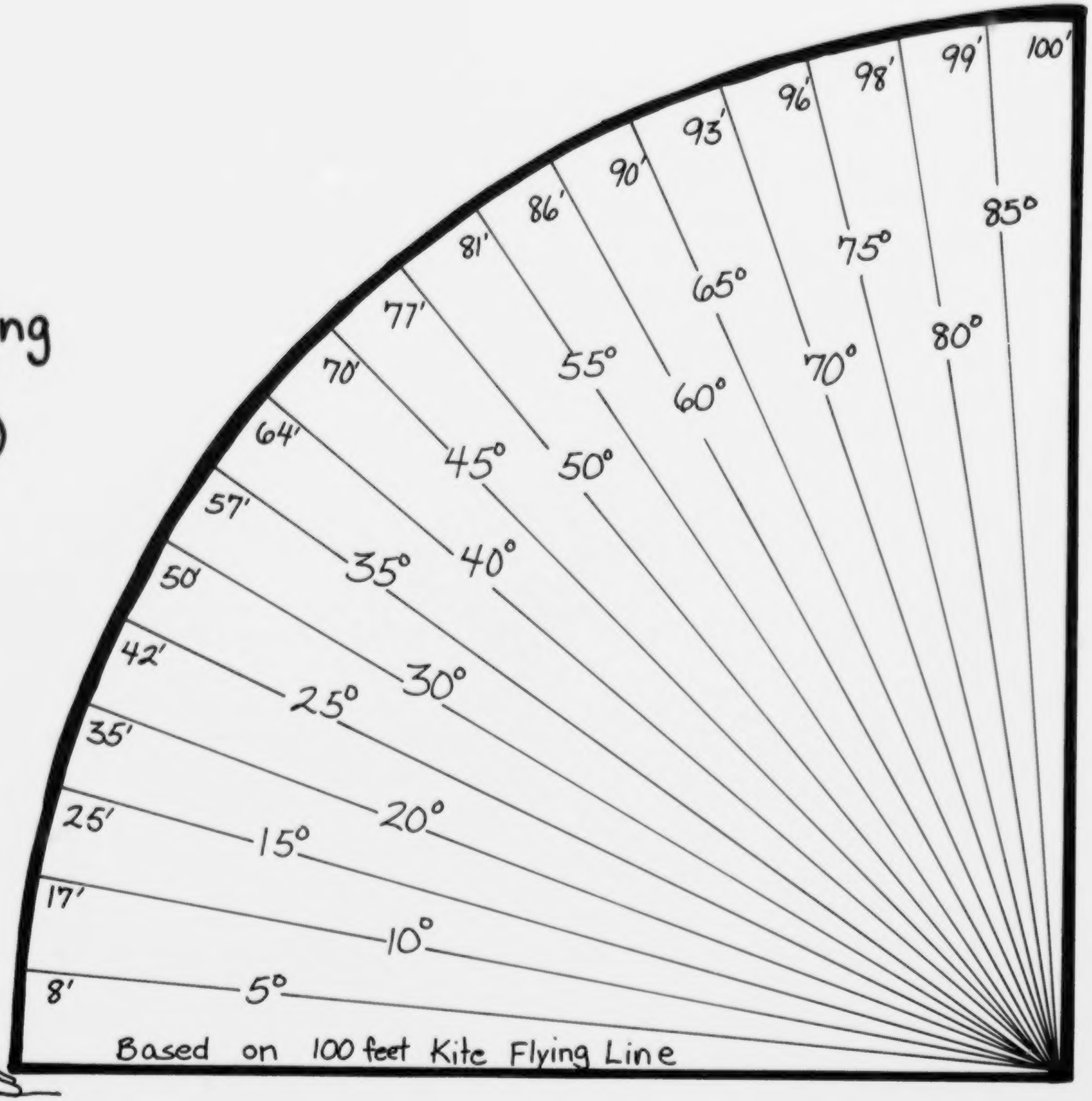
Ranged Distance to Kite, or Length of Line (Feet)

ANGLE (DEGREES) TO KITE	100	150	200	250	300	350	400	450	500	750	1000
5°	8	13	17	22	26	30	34	39	43	64	86
10°	17	26	34	43	52	60	68	78	87	128	174
15°	25	39	50	64	78	90	100	116	129	193	250
20°	35	51	70	85	103	120	140	153	170	256	340
25°	42	63	84	105	126	147	168	190	211	316	422
30°	50	75	100	125	150	175	200	225	250	375	500
35°	57	84	114	142	169	199	228	256	286	428	570
40°	64	95	128	159	190	223	256	285	320	480	640
45°	70	106	140	176	212	247	280	318	350	528	707
50°	77	115	145	191	230	268	290	345	383	574	766
55°	81	123	162	204	246	286	324	378	406	612	810
60°	86	129	172	216	259	303	348	389	430	648	860
65°	90	136	180	226	273	317	360	408	451	678	906
70°	93	140	187	234	279	328	374	422	470	704	940
75°	96	144	192	241	288	338	385	434	482	724	965
80°	98	147	196	246	295	344	393	442	492	738	980
85°	99	149	198	247	297	347	396	446	495	744	990
90°	100	150	200	250	300	350	400	450	500	750	1000

ALTITUDE OF KITE (FEET)


STRAW SIGHTER
TABLE

Altitude Determining Card (FEET)


5°
10°
15°
20°
25°
30°
35°
40°
45°
50°
55°
60°
65°
70°
75°
80°
85°
8'
17'
25'
35'
42'
50'
57'
64'
70'
77'
81'
86'
90'
93'
96'
98'
99'
100'
Based on 100 feet Kite Flying Line

Form Number 202122 AK

Section Number 11PAK

Official Use Only AW WP
LE ZZ

FLIGHT DATA SHEET

Project Manager ______________

Sponsoring Firm ______________

Address ______________

____

Testing and Evaluation Form 192021 A

PREFLIGHT INFORMATION

Kite Name ______________

Kite Number ______________

Type of Kite ______________

Date Completed ______________

MODEL SPECIFICATIONS

Length ______________

Width ______________

Shape ______________

Area ______________

Weight ______________

Signature

Materials ______________

____

Bonding Agent ______________

Attachment of Flying String ______________

Tail Yes ______ No ______ Specify ______________

Design Engineer

CONSTRUCTION PROCESS

Please describe below the construction process, making particular mention of difficulties encountered or special manufacturing techniques.

Signature Construction Engineer

COLOR SCHEME ______________

DISTINGUISHING MARKS, IF ANY ______________

BEAUFORT NUMBER

AND LAND WIND EFFECT

(For use with section 22W)

m.p.h.	Beaufort Number	Land–wind effect	Designation of wind
0–1	0	Calm; smoke rises vertically	Light
1–3	1	Wind direction just shown by smoke	Light
4–7	2	Wind felt on face; leaves rustle	Light
8–12	3	Leaves and small twigs in motion	Gentle
13–18	4	Dust rises; small branches move	Moderate
19–24	5	Small trees in leaf begin to sway	Fresh
25–31	6	Large branches move	Strong

Form Number 202122 AK Section Number 22R

OFFICIAL USE ONLY X Z PQ W

PREFLIGHT CHECKLIST

(In order to comply with insurance regulations, this section must be completed and initialed by the flight engineer prior to flight.)

☐ 1. ______________________________
☐ 2. ______________________________
☐ 3. ______________________________
☐ 4. ______________________________
☐ 5. ______________________________
☐ 6. ______________________________
☐ 7. ______________________________
☐ 8. ______________________________
☐ 9. ______________________________
☐ 10. ______________________________

Initialed ______________________________ Flight Engineer

Section Number 22W

WEATHER CONDITIONS

	Flight No. 1	Flight No. 2	Flight No. 3	Flight No. 4
Wind Direction				
*Wind Velocity/Beaufort No.				
*Wind Velocity/Range or Actual				
Humidity				
Temperature				
Visibility				
Remarks				
Date and Verification †				

*USE TABLE PAGE 1. Look for appropriate description of effect; find Beaufort Number; record range (eg. No. 5 indicates 19–24 mph.) or call the Weather Bureau. † Initial–Flight Engineer

Add Written Evaluation On Reverse Side

FLIGHT DATA

Section 22FDAK

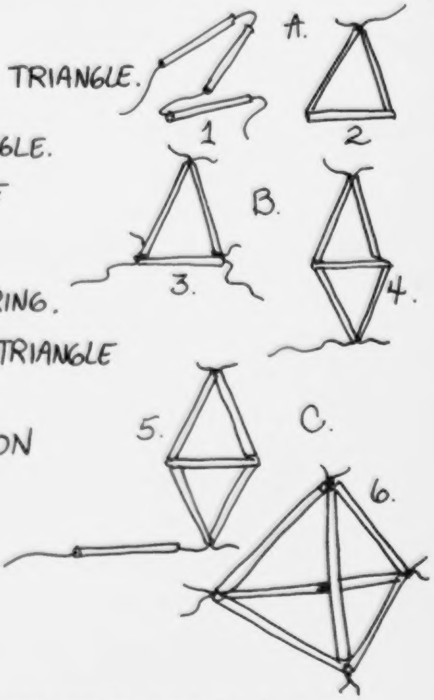
		Flight No. 1, / /	Flight No. 2, / /	Flight No. 3, / /	Flight No. 4, / /
ALTITUDE	Estimated Altitude				
	Angle				
	Computed Altitude				
FLIGHT DURATION					
STABILITY INFORMATION					
FLIGHT PERFORMANCE					

Initial

BERNOULLI WAS A "BIRD-BRAIN!"

I. MAKING THE TETRAHEDRON KITE

FOR EACH TETRAHEDRON, YOU WILL NEED: 6 STRAWS, 1 PIECE OF STRING ABOUT 1METER IN LENGTH, AND 2 PIECES OF STRING ABOUT 35cm LONG.



A. PUT 3 STRAWS ON THE METER STRING AND TIE THEM INTO A TRIANGLE.

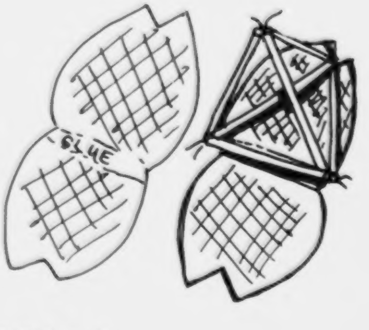
B. TIE EACH OF THE SHORTER STRINGS TO A CORNER OF THE TRIANGLE. SLIP A STRAW ONTO EACH STRING AND TIE THE TWO STRINGS TOGETHER TIGHTLY.

C. Slip A THIRD STRAW ONTO ON OF THE LOOSE ENDS OF STRING. TIE THE END OF THE STRING TO THE POINT OF THE TRIANGLE THAT HAS NOTHING TIED TO IT YET. THIS SHOULD COMPLETE YOUR FIRST TETRAHEDRON

D. MAKE THREE MORE TETRAHEDRONS LIKE THIS FIRST ONE.

II. CUTTING OUT THE GORES

THE SECTIONS WHICH MAE UP THE COVERINGS OF THE KITE, CALLED GORES, CAN ALL BE CUT FROM ONE PIECE OF TISSUE PAPER. FOLLOW THE DIRECTIONS GIVEN ON THE PATTERN FOR A GORE.



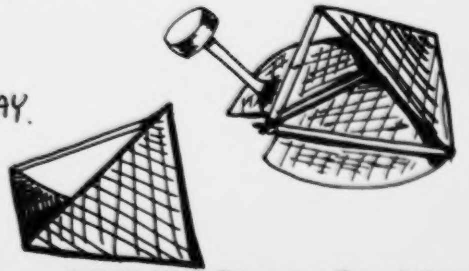
III. MOUNTING THE GORES

A. PUT A SMALL AMOUNT OF GLUE ALONG THE FOLD IN THE CENTER OF A GORE. LAY ANY ONE STRAW OF A TETRAHEDRON ALONG THE FOLD.

B. COVER BOTH OF THE TISSUE PAPER FLAPS LYING OUTSIDE THE STRAW TRIANGLE WITH GLUE. FOLD THESE FLAPS OVER THE STRAWS AND GLUE THEM DOWN INSIDE THE TRIANGLE.

C. PIVOT THE TETRAHEDRON SO THAT THE OPPOSITE SIDE OF IT COMES DOWN ON THE OTHER SIDE OF THE GORE. GLUE THE FLAPS AS BEFORE.

D. COVER THE OTHER THREE TETRAHEDRA IN THE SAME WAY. NOTICE HOW THEY LOOK LIKE BIRDS.

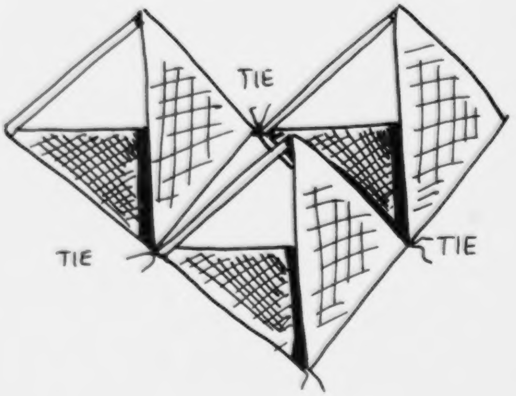


BERNOULLI WAS A "BIRD BRAIN"!

IV. PUTTING THE KITE TOGETHER

A. ARRANGE THREE OF THE TETRAHEDRA IN A TRIANGLE AS SHOWN. BE SURE THAT ALL THE GORES ARE FACING THE SAME WAY.

B. USING THREE PIECES OF STRING, TIE THE THREE TETRAHEDRA TOGETHER TIGHTLY AT THE THREE PLACES WHERE THEY TOUCH EACH OTHER

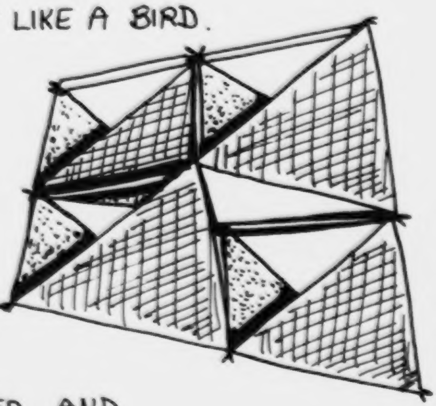


C. PLACE THE FOURTH TETRAHEDRON ABOVE THE TRIANGLE FORMED BY THE FIRST THREE. USING THREE MORE PIECES OF STRING, TIE TIGHTLY IN PLACE.

V. GETTING READY TO FLY

A. CUT OFF ALL LEFT OVER STRINGS. TIE A STRING FOR FLYING AT THE "HEAD" OF ONE OF THE LOWER "BIRDS", OR TETRAHEDRA.

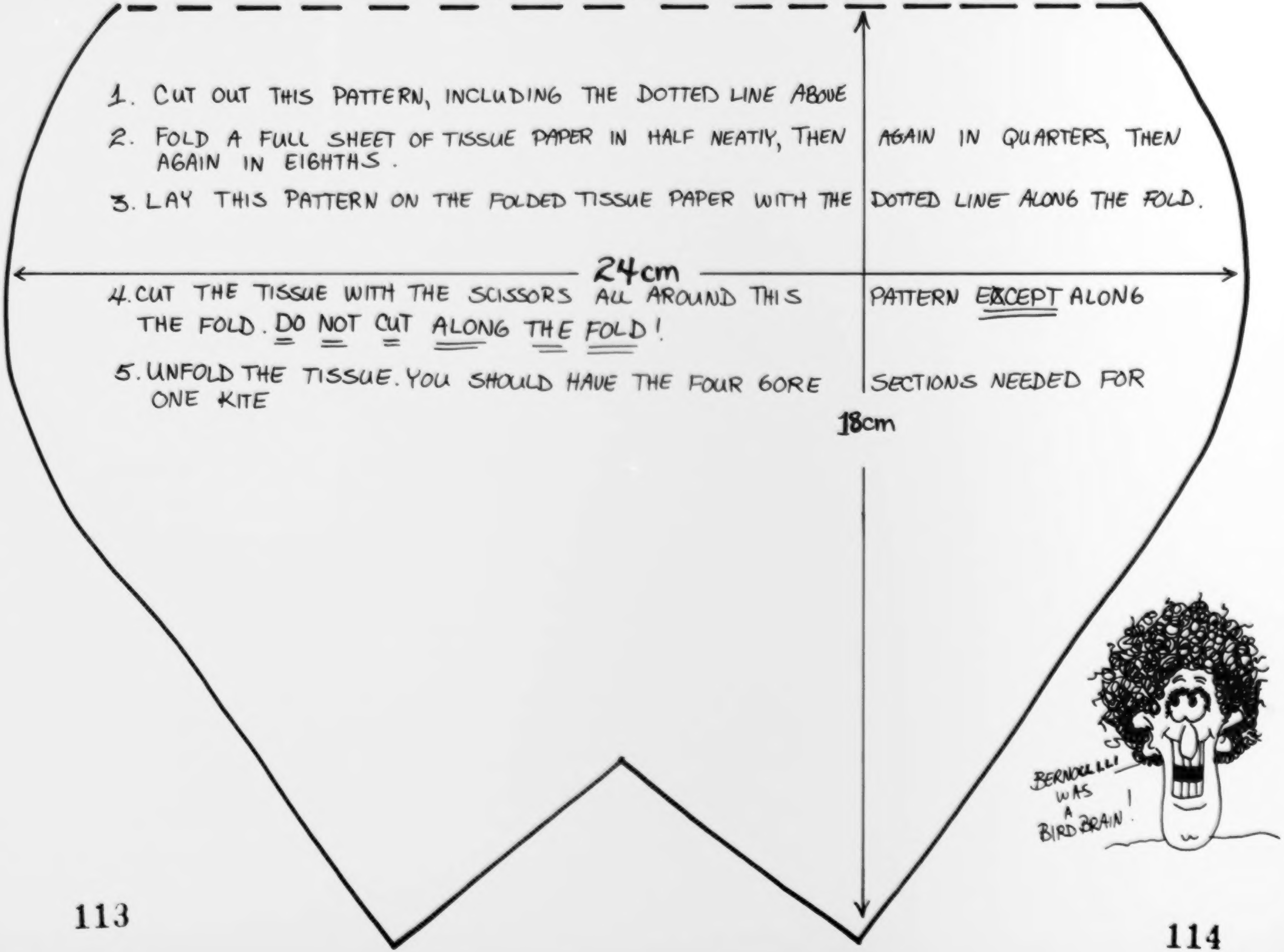
B. TIE YOUR KITE STRING TO THE "HEAD" STRING. FLY IT LIKE A BIRD.



TO THINK ABOUT:

1. WHAT IS THE RATIO BETWEEN THE NUMBER OF UNCOVERED AND COVERED SIDES?
2. WHAT IS THE RATIO BETWEEN THE COVERED AND UNCOVERED SURFACE AREA?
3. WHAT IS THE RATIO BETWEEN THE VOLUME OF ONE OF THE FOUR SMALL TETRAHEDRA TO THE WHOLE KITE?
4. IF YOU WANTED TO ENLARGE THE KITE AND MAINTAIN A SIMILAR SHAPE, HOW MANY MORE TETRAHEDRA WOULD YOU HAVE TO ADD?

TETRAHEDRAL KITE - PATTERN FOR TISSUE PAPER GORE SECTIONS



1. CUT OUT THIS PATTERN, INCLUDING THE DOTTED LINE ABOVE
2. FOLD A FULL SHEET OF TISSUE PAPER IN HALF NEATLY, THEN AGAIN IN QUARTERS, THEN AGAIN IN EIGHTHS.
3. LAY THIS PATTERN ON THE FOLDED TISSUE PAPER WITH THE DOTTED LINE ALONG THE FOLD.
4. CUT THE TISSUE WITH THE SCISSORS ALL AROUND THIS PATTERN **EXCEPT** ALONG THE FOLD. **DO NOT CUT ALONG THE FOLD!**
5. UNFOLD THE TISSUE. YOU SHOULD HAVE THE FOUR GORE SECTIONS NEEDED FOR ONE KITE

______________ NAME

BERNOULLI WAS A BIRDBRAIN

YOU ARE WORKING WITH TRIANGLES AND THE SOLIDS THAT CAN BE CONSTRUCTED FROM THEM — (tetrahedra). WORKING THIS SHEET AS YOU GO WILL HELP YOU FIND OUT MANY INTERESTING PRINCIPLES OF GEOMETRY. YOU WILL NEED A RULER AND PROTRACTOR.

1. YOU HAVE JUST CONNECTED 3 STRAWS TO MAKE A TRIANGLE. RECORD ALL THE FACTS YOU KNOW ABOUT IT:

LENGTH OF A SIDE = ______________ ALL SIDES ARE ______________

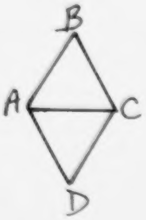
MEASUREMENT OF AN ANGLE = ______________ ALL ANGLES ARE ______________

ALTITUDE OF THE TRIANGLE = ______________ SUM OF THE MEASUREMENTS OF THE ANGLES ______________

AREA OF THE TRIANGLE = ______________

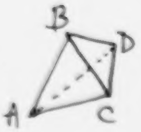
THIS TYPE OF TRIANGLE IS CALLED AN ______________ TRIANGLE.

2. BY ADDING 2 MORE STRAWS, YOU HAVE A RHOMBUS. RECORD ALL THE FACTS YOU KNOW ABOUT IT.



A RHOMBUS IS A QUADRILATERAL BECAUSE IT HAS FOUR (QUAD-) SIDES (-LATERAL).

3. WHEN YOU ADD THE LAST STRAW, YOU HAVE MADE A TETRAHEDRON. THIS IS A THREE-DIMENSIONAL FIGURE HAVING LENGTH, WIDTH, AND HEIGHT.



HOW MANY TRIANGULAR FACES DOES IT HAVE? ______ ARE THEY ALL ≅? ______

WHAT, THEN, IS IT'S SURFACE AREA? ______________

WHAT IS ITS VOLUME? ______________

WHAT IS THE RATIO BETWEEN COVERED SIDES AND UNCOVERED SIDES? ______________

4. WHEN THE KITE IS ASSEMBLED, WHAT SHAPE IS IT? ______________

THE ENTIRE KITE IS "SIMILAR" TO ONE CELL. WHAT IS THE SAME ABOUT IT? ______________

WHAT IS DIFFERENT ABOUT IT? ______________

WHAT IS THE RATIO BETWEEN COVERED AND UNCOVERED TRIANGLES IN THE WHOLE KITE?

WHAT IS THE SURFACE AREA OF THE WHOLE KITE? ______________

WHAT IS THE VOLUME OF THE WHOLE KITE? ______________

WHAT IS THE RATIO BETWEEN THE SURFACE AREA OF ONE CELL AND THE WHOLE KITE? ______________

WHAT IS THE RATIO BETWEEN THE VOLUME OF ONE CELL AND THE WHOLE KITE? ______________

CLASS CHART

PILOT	TRIAL 1	TRIAL 2	TRIAL 3	TOTAL	AVERAGE
1.					
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